NATURE

No. 4649 SATURDAY, DECEMBER 6, 1958 Vol. 182

CONTENTS

	Page
Human Relations in Industry	1539
Scientific Apparatus in the Royal Institution. By Sir Lawrence Bragg, F.R.S.	1541
Effects of Atomic Radiation. By Dr. C. Auerbach, F.R.S.	1543
Iodine-131 in Human Thyroids following the Windscale Reactor Accident. By G. Maycock and J. Vennart	1545
Progress of Cancer Research	1547
Obituaries :	
Dr. Felix Oswald. By Prof. H. H. Swinnerton	1549
Dr. Francisco Duran-Reynals. By Prof. A. Haddow, F.R.S.	1549
Dr. R. C. Fisher. By J. D. Bletchly	1549
News and Views	1550
The Commonwealth Scientific and Industrial Research Organization, Australia	1555
Pulp and Paper Research Institute of Canada. By S. Lammle	1556
Science and Civilization	1557
Radio Research, 1957. By Geoffrey M. Brown	1558
Ecology of Soil Fungi. By Dr. G. J. F. Pugh and Dr. G. W. F. Sewell	1559
Physics of Ice Movement. By Dr. J. W. Glen	1560
The Human Operator and High-Speed Flight. By A. Cadman Clinton	1562
Hydromedusae New to the British List from the Firth of Clyde. By C. Edwards	1564
Nucleotide Pool of Brewers' Yeast during Growth and Fermentation. By G. Harris, J. W. Davies and R. Parsons	1565
Presence of a Factor inhibiting Biting in *Aedes aegypti*. By M. M. J. Lavoipierre	1567
Magnetic Properties of Spin-free Transition Series Complexes. By Dr. B. N. Figgis	1568

Letters to the Editors :

A New Method of fractionating High Polymers.—Dr. F. W. Peaker and Prof. J. C. Robb 1591
Production of Compounds labelled with Carbon-14 from Carbon-14 Dioxide accelerated in an Electric Field.—M. Guillaume 1592
Hydrogen Overpotential on Germanium Electrodes.—V. R. Erdélyi and Mino Green 1592
Macroscopic Surface Structures formed on Boron upon Solidification.—Claude P. Talley 1593
Extractives from Klinki Pine (*Araucaria klinkii* Lauterbach).—W. E. Hillis and Ann Carle 1593
Potassium Uptake by Cation-Exchange Resins from Soils and Minerals.—P. W. Arnold 1594
Aluminium Interlayers in Soil Clay Minerals, Montmorillonite and Vermiculite.—B. L. Sawhney 1595
Ionospheric Measurements made at Halley Bay.—W. H. Bellchambers and W. R. Piggott 1596
Observations on the Explosion at Ripple Rock.—J. K. Wright, E. W. Carpenter, A. G. Hunt and B. Downhill 1597
Presence of 6707 A. Radiation in the Twilight Sky.—M. Gadsden and K. Salmon 1598
Behaviour of the Present Sunspot Cycle.—C. M. Minnis; Prof. S. W. Visser 1599
Maxwell Fish-eye treated by Maxwell Equations.—Prof. Chen To Tai 1600
Separation of the Condensing Enzyme of *Aspergillus niger* from Acetyl Coenzyme A Deacylase and Citridesmolase and the Effect of Magnesium Ion on the Purified Fraction.—Prof. C. V. Ramakrishnan 1601
A Rapid Paper Chromatographic Procedure for the Quantitative Determination of Hydroxyproline—Henry R. Roberts, Michael G. Kolor and Wesley Bucek 1602
Anæmia and Liver Damage in X-irradiated Animals.—Dr. M. Skalka 1602
Effect of Thyroid Pre-treatment on the Mortality of X-Irradiated Mice.—Dr. M. Pospíšil and Dr. L. Novák 1603
Chemistry of the Rhodopsin Cycle.—Tōru Yoshizawa and Yuji Kitō 1604
Biochemical Characteristics of Dog Semen.—D. J. Bartlett 1605
Effect of Drugs on Emotional Behaviour in Rats.—R. W. Ryall 1606
Zinc Deficiency induced by Mercury in *Coffea arabica*.—K. R. Bock, J. B. D. Robinson and G. T. Chamberlain 1607
Labelling of Cells in Thoracic Duct Lymph of the Guinea Pig after Tritiated Thymidine.—Prof. J. M. Yoffey, Prof. N. B. Everett and Prof. W. O. Reinhardt 1608
Some Structural Characteristics of Myelinated Nerve Fibres.—Dr. C. P. Wendell-Smith and Dr. P. L. Williams 1608
Giant Nerve Cells and Fibres in *Arenicola claparedii* (Polychæta).—Prof. G. P. Wells, F.R.S. 1609
Anti-brucella Phage.—Prof. Józef Parnas, A. Feltynowski and W. Bulikowski 1610
An Electron-Microscopic Study of the Ciliature of the Trochophore Larva.—Dr. H. Seuntjens and Dr. W. G. Braams 1611
Gibberellic Acid and Vernalization.—Prof. S. C. Chakravarti 1612
Response of Cacao to Fertilizers.—D. B. Murray 1613
Yield Variations in Tree Crop Experiments with Specific Reference to Cacao.—T. A. Jones and G. K. Maliphant 1613
The Macronucleus of *Spirostomum*.—Prof. B. R. Seshachar 1614
Embryology of *Atkinsonia ligustrina* (A. Cunn. ex F. Muell.) F. Muell.—Miss Sudha Garg 1615
Purification and Serology of Cucumber Mosaic Virus.—Dr. J. A. Tomlinson, Dr. R. J. Shepherd and Prof. J. C. Walker 1616
Observations on the Spread of Mouse Polyoma Virus Infection.—Dr. Wallace P. Rowe, Janet W. Hartley, Isadore Brodsky, Robert J. Huebner and Lloyd W. Law 1617
Biochemical Changes in Virus-infected and Regenerating Mouse Liver.—David S. Nelson and Prof. P. M. de Burgh 1617
Mutations in L-Forms.—Zb. Lorkiewicz and Irena Zelazna 1619
Somatic Chromosomes of *Leptaspis* and *Streptogyna* (Poaceae).—Dr. T. Tateoka 1619
Transformation of a Monochlamydius into a Dichlamydius Chimæra by X-ray Treatment.—Dr. H. W. Howard 1620
Gene Control of Specificity and Activity : Loss by Mutation and Restoration by Complementation.—Prof. D. Lewis, F.R.S. 1620
Analogies between the Compensatory Responses of Fish and Crustacea to Horizontal Displacement of the Body.—D. H. A. Marr 1621
The Teleostean Swim-bladder.—Prof. C. Adrian M. Hogben. 1622

Review Supplement :

William Harvey and his Critics. By Dr. Douglas Guthrie 1571
Perception and Communication. By J. A. Deutsch 1572
Evolution of the Human Mind. By Prof. H. J. Fleure, F.R.S. 1572
Human Sterility and Fertility. By Dr. Kenneth Walker 1573
The Arrhythmias. By Dr. J. P. D. Mounsey 1574
Treatise of Zoology. By Prof. C. H. O'Donoghue 1574
Transport across Cell Membranes 1575
Biological D-Days. By Prof. Ronald Good 1576
Virus Structure and Function. By Dr. M. R. J. Salton 1576
An Introduction to Physiology. By Prof. W. Stiles, F.R.S. 1577
Tea. By Dr. F. N. Howes 1577
Enzyme Kinetics. By Dr. B. R. Hammond 1578
Insecticides. By Prof. Wd. Eichler 1578
A Scientific Analysis of Fixation and Dyeing. By Prof. J. Brachet 1579
Mass Spectroscopy. By Dr. G. Dearnaley 1579
The Gravitational Field of the Earth. By Sir Edward Bullard, F.R.S. 1580
Mechanical Vibration. By Prof. R. E. D. Bishop 1581
Geophysical Volumes of the Handbuch der Physik. By Sir Edward Bullard, F.R.S. 1582
Problems of High-speed Flight. By Dr. W. P. Jones 1582
Computers Galore. By Dr. A. D. Booth 1583
Improprieties Resolved. By Prof. T. A. A. Broadbent 1584
Morley College. By Prof. W. H. G. Armytage 1585
Secondary Modern Schools in Britain. By H. Raymond King 1585
Fundamentals of Symbolic Form. By F. I. G. Rawlins 1586
Short Reviews 1587

SPECIFY.... DIFCO

microbiological reagents and media

CULTURE MEDIA · MICROBIOLOGICAL ASSAY MEDIA
TISSUE CULTURE AND VIRUS MEDIA · SEROLOGICAL REAGENTS
ANTISERA · DIAGNOSTIC REAGENTS · SENSITIVITY DISKS · UNIDISKS
PEPTONES · HYDROLYSATES · AMINO ACIDS · ENZYMES · ENRICHMENTS
DYES · INDICATORS · CARBOHYDRATES · BIOCHEMICALS

Difco Laboratories

Over 60 years' experience assures
UNIFORMITY · STABILITY · ECONOMY

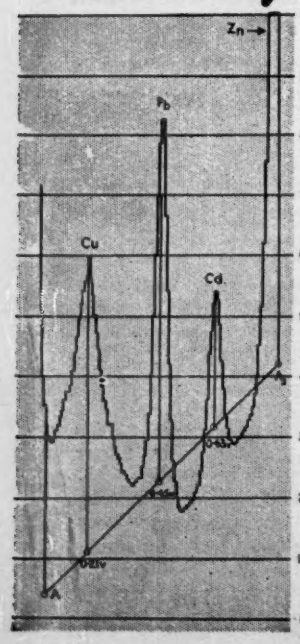
Prompt delivery from U.K. stock. Write for Difco Manual and technical leaflets to the sole agents :
BAIRD & TATLOCK (LONDON) LTD., CHADWELL HEATH, ESSEX, ENGLAND
Branches in London, Manchester and Glasgow. *Agents throughout U.K. and all over the world.*

BTL **complete laboratory service**

TAS/DO.1.

* COPPER · LEAD · CADMIUM....with ZINC

How long would it take to analyse



by CONVENTIONAL METHODS, a solution having the following metals present —

COPPER - -	3 p.p.m.	CADMIUM - -	2 p.p.m.
LEAD - - -	7 p.p.m.	ZINC -	200,000 p.p.m. ?

These Square Wave Polarograms recorded by the

MERVYN-HARWELL
SQUARE WAVE POLAROGRAPH Mk. III

are reproduced here to show the identification of these metals, in these proportions, in solution. Note the high ratio of Zn to Cd., without interference. The peaks are identified by the automatic potential markers AA_1, which enable half-wave potentials accurately to be established. Permanently recorded on a 10" wide chart.

**This was an actual problem presented to Mervyn Instruments by a leading chemical manufacturing organisation.*

Speediest, most Accurate, the Fundamental Development in Analysis—and therefore the most Economic. Convenient in Design, Sensitive in Application.

Send for our full technical leaflets, quoting "Nature" to

MERVYN INSTRUMENTS

COPSE ROAD, ST. JOHN'S, WOKING, SURREY.
Telephone: Woking 5200.

HUMAN RELATIONS IN INDUSTRY

THE final report of the Joint Committee on Human Relations in Industry* covers the three years from the issue of the Committee's first report in March 1954 until, on the termination of the Conditional Aid Scheme on March 31, 1957, the Joint Committee, like that on Individual Efficiency in Industry, was disbanded. Eventually, in November 1957, the Council for Scientific and Industrial Research set up a permanent Human Sciences Committee to advise on future support by the Department of Scientific and Industrial Research for research in these sciences, especially that relating to the design of equipment, training and human relations in industry. The work carried out by both Joint Committees is briefly reviewed in reports which are here published under one cover; but the main interest of both reports lies in their discussion of policy and survey of the general position of research in this field.

The period of office of the two Committees has witnessed a real development of research in the field of human relations in industry and a big growth of industrial interest in such research. Both opportunities and needs are now more clearly understood, and although the work of both Committees was dominated, and probably excessively so, by the funds made available under the Conditional Aid Programme and derived from United States economic aid, which led to research being concentrated on the study of problems arising out of practical situations, the Committee on Human Relations in Industry believes that valuable lessons can be learnt from its experience. New lines of study, for example, were opened up and new ideas introduced into academic thinking. The formation of new research groups was prompted and facilitated, and these groups and many recently qualified workers have been attracted to the study of human problems in industry.

Nevertheless, the Committee points out that such conditions can lead to distorted effort, and those lines of research which add to underlying knowledge but are only indirectly relevant to immediate practical purposes are liable to be neglected. Studies of this character provide the foundation essential to short-term investigations of practical problems, and the Committee takes the view that future arrangements for financing social research from public funds should provide for work of a basic, long-term character. It does not, indeed, appear from these reports that this undue reliance on Conditional Aid Funds led, in fact, to the promotion of projects of dubious value, as was suggested at the time (cf. *Nature*, 174, 50; 1954); but it is scarcely to the credit of Britain that in accepting the generous offer of the United States this lack of balance should have been allowed to develop through failure to supply the further funds which already in 1954 were recognized as needed. The newly established Human Sciences Committee intends to encourage both basic and applied research for the promotion of the growth of psychology and sociology, and to make further contributions to the solution of the practical problems of industry and society; but Government support could equally well have been used five years ago to check the obvious tendency of Conditional Aid Funds to divert effort from such fundamental research.

The Committee on Human Relations in Industry recognizes that fundamental and applied research in this field are closely related. Some of the best projects it has sponsored have combined an attack on practical problems with penetration of underlying theoretical issues. It suggests that it is characteristic of social science that the best results come from those who are able to operate at both the practical and theoretical levels; but nevertheless, the Committee is convinced that opportunities must be available for research workers of high calibre to pursue fundamental studies.

Nor is this the only problem of balance. It is equally important to correct the piecemeal character of much social research in industry, and ensure that the right targets are selected. The Committee sought to meet the criticism from industry that the problems studied by academic social scientists are trivial, or of past, rather than present, interest, and that the priorities are wrong, by going to industry for suggestions; some research arising from suggestions originating from industry was included in its programme. Its experience, however, led to the conclusion that academic research groups readily welcome suggestions from industry concerning the problems that merit study; any reticence on their part is usually related to difficulties in arriving at a research method and plan that will meet scientific requirements and in finding competent research workers. Further, to develop a bare suggestion for research into a realistic research project requires much further discussion and detailed formulation, and, in consequence, a considerable amount of effort from the industrial organization responsible for the suggestion.

To secure the contribution of both the research group and the industrial organization is thus not a simple proposition; but the Committee is convinced that industrial needs will only be properly reflected in the research programmes of academic research groups if this joint approach is widely adopted. Real progress depends on individual research groups finding ways and means of associating industry more closely with their work, not only in its execution and

* Department of Scientific and Industrial Research. Final Report of the Joint Committee on Human Relations in Industry 1954–57 and Report of the Joint Committee on Individual Efficiency in Industry 1953–57. Pp. vi+44. (London: H.M. Stationery Office, 1958.) 3s. net.

in the application of its results but also in the choice of the problems to be investigated.

Nor is such a balanced effort solely a matter of collective judgment on the part of those sponsoring the research. Administrative arrangements can also be an important factor, in that as these at present stand there is no point at which both the funds available and the whole range of projects to be considered are known. The Human Sciences Committee will not be effective unless public financial support for social research programmes has much more continuity than in the past. A settled policy of support is needed and *ad hoc* administrative arrangements should be terminated.

Before considering the Committee's comments on the ways in which financial assistance should be given, there is a further factor to be considered which bears on this question of continuity. The main obstacle to the healthy growth of social research in industry remains the shortage of trained people. The Committee admits that only a few project leaders capable of planning and directing research have emerged as a result of the work done during the past three years. This crucial deficiency is attributed to the lack of reasonable career prospects; for this reason, research organizations are faced with a steady drain to industry of their best people just when they promise to be most useful—as senior scientists competent to take immediate charge of research projects under the general supervision of the director of research.

Since many of the social research groups are built around one senior person, whose transfer to industry means the disintegration of the group, the Committee concludes that a main object of future public support should be to create a number of stable research groups of viable size, characterized by a higher ratio of senior to junior staff, so as to reduce vulnerability as well as provide adequate supervision, and by a sufficient size to provide young research workers with an intellectually stimulating environment in which to learn the craft of research. Moreover, such a step should contribute towards establishing the independence of social research workers, a matter on which the Committee also lays great stress. It considers that Britain is fortunate in that social research workers have been able to maintain the impartiality and independence of their scientific role, but its continuance depends on ability to gain and retain confidence. It is essential here that social research workers should recognize that the choice between different social objectives is a matter for those directly concerned in the industry, and not for them in their scientific capacity.

The Committee distinguishes three types of research groups which require financial assistance. For those seeking to enter the field but possessing neither the experience nor the proved competence to focus their research interests immediately and to formulate an appropriate research method, assistance should be limited to a period of two or three years. The work of the more mature groups, with well-developed industrial contacts, is probably best supported on the basis of individual projects over an agreed period. But neither group can develop the measure of stability in personnel and the long-term scientific strategy needed for fundamental research if its finance is wholly *ad hoc*. Besides these two groups, the Committee visualizes grants by the Department of Scientific and Industrial Research or the Medical Research Council to enable the universities or independent research institutes to create stable research units for the study of subjects of joint interest.

Apart, however, from indicating that the universities or independent research institutes would be expected normally to provide the necessary foundation of uncommitted, long-term support, and emphasizing the importance of social research in industry being recognized as an established university interest to be supported by normal university funds, the Committee does not seem to consider the implications of such a system or how co-ordination and balance are in practice to be secured. The Committee does not attempt to re-open the question whether or not a Social Science Research Council should now be established, and it could scarcely have been expected to ask whether the Department of Scientific and Industrial Research or the Medical Research Council is the most appropriate body either to co-ordinate social science research or to distribute public funds for such research. These, however, are the critical questions, and they require further discussion, especially in the light of evidence that the Department of Scientific and Industrial Research and even the Lord President's office as at present constituted are unable to function effectively in that way, and also in relation to the wide issues on the control of expenditure on research raised by the recent report of the Select Committee on Estimates.

In the light of the evidence submitted to that Committee, it seems essential that the method of distribution of research grants and the way in which expenditure is to be controlled and co-ordinated should be carefully considered before any new administrative arrangements are made for research grants, especially through existing bodies. Moreover, in view of what the Committee remarks about the importance of associating more of the larger industrial firms with research and the development of research teams in this field, it might be well to associate industry with the development of any such administrative arrangements. To do so could well lead to suggestions for improved arrangements, and the independent foundations may also have something to contribute here, apart from what they are already doing to encourage growing points in actual research. Indeed, the Committee on Human Relations in Industry stresses the importance of seeking co-operation from the many institutions the interests of which could be brought to bear on the development of social research in industry, and refers specifically to the technical colleges, the industrial research associations and national bodies concerned with industry.

The Human Sciences Committee is stated to be taking up proposals for research on a relatively large scale from certain well-established research groups which between them cover the whole field from experimental psychology to sociology; but it seems more than a little doubtful whether a body within the Department of Scientific and Industrial Research can have either the authority and status—or the resources—to ensure development of a co-ordinated programme of research, quite apart from the question whether this is the appropriate point from which such an attempt should be made. This is not to suggest that the Department can make no contribution in its own right: on the utilization of results and questions of communication it has a growing volume of experience, including some current studies, which should be of direct assistance, and research associations should also be able to help in the selection of problems, not simply those bearing on productivity but equally with regard to industry in its broad social context and in relation to future developments. Nevertheless, even the Council for Scientific and Industrial Research seems likely to lack the standing that is required to put social research in industry on the basis that is now required.

The Joint Committee on Individual Efficiency in Industry has little to add about policy; but that little is in line with what is said by the Committee on Human Relations in Industry. It does not, indeed, regret the initial emphasis on short-term research in its programme, as at the present stage of development the success of such projects and the use of their results in industry are likely to provide fresh ideas for basic research and open up new facilities for research workers in industry. It is, however, equally convinced of the need for balanced activity, and sees the need in the future to encourage the parallel growth of fundamental and applied research and the application of results. Moreover, it recognizes even more explicitly that action is required which goes beyond the particular responsibilities of the Medical Research Council and the Council for Scientific and Industrial Research, and it recommends in particular that certain problems of training and of the supply of trained scientific man-power—including the need to teach future engineers something of the difference between the characteristics of the human being and the machine—should be referred to the Lord President for comprehensive examination.

That particular proposal is open to Sir Hugh Beaver's recent criticisms; but it does indicate the need for a much wider examination of the situation and at a high level, at least by the Advisory Council on Scientific Policy, the observations of which on the report should be made without delay. This is even more urgent and fundamental than the survey of research needs which the Department of Scientific and Industrial Research is already undertaking. The Joint Committees have analysed the situation and needs with admirable lucidity and exemplary restraint, and their reports supply all that is needed to enable those concerned to ensure that research into the social and human problems of industry should be adequately supported and competently pursued, to press for the further examination at the appropriate level of the administrative problems of financial support and control, and the co-ordination of such research as well as the interpretation and communication of its results.

SCIENTIFIC APPARATUS IN THE ROYAL INSTITUTION*

By Sir LAWRENCE BRAGG, F.R.S.

THE stores of the Royal Institution contain many interesting examples of apparatus which has been used for research or lecture demonstrations, or which has been given or bequeathed to the Institution. The most valuable and historic pieces are on permanent display in the ambulatory around the lecture theatre. An overhaul of the collections has recently been undertaken, and in the course of this work many treasures have been rediscovered and interesting facts about their history have come to light. It is not easy to select from such a wealth of material. The examples to be mentioned may seem to have little connexion with each other. But, taken together, they form a connected story, because they all date from at least eighty years ago and they outline the state of knowledge at that time, the phenomena in which the physicists were mainly interested, the kind of apparatus they used for demonstration, and the instrument makers' art of the period. The examples will be chosen from the main branches of physics: mechanics, sound, light, electrostatics, and electromagnetism.

The first example is a mechanical model for illustrating the combination and interference of waves (Fig. 1), and is a very elegant piece of instrumentation. It came to the Royal Institution in the De la Rue collection. Warren De la Rue was elected a member of the Royal Institution in 1851, and made a number of gifts during his lifetime. After his death, his widow presented his collection. The instrument shows five wave-forms simultaneously; the motions of the white beads on its upper part are always the sum of the

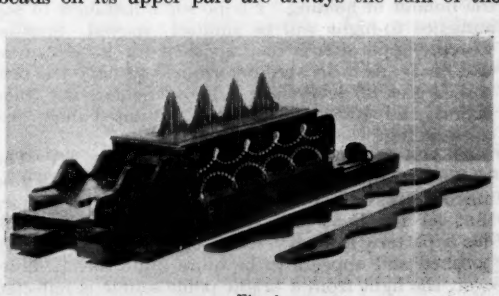


Fig. 1

* Substance of a Friday Evening Discourse at the Royal Institution delivered on October 24.

two wave motions set on either side. The positions of the beads are determined by vertical and horizontal wave guides, and in an ingenious way the component waves can be given any phase and amplitude and various wave-lengths. It shows the combination of waves of different wave-lengths, interference of waves of the same wave-length, and plane, circular or elliptical polarization. It is said to have been designed by Wheatstone.

The next exhibit is one of the original Edison phonographs, shown by W. H. Preece before the Society of Telegraph Engineers on February 27, 1878. He said: "I may tell you that this instrument is only the second which Mr. Edison, the wonderful genius on the other side of the Atlantic, has ever made. It was brought over from America by my friend Mr. Puskas. . . . Some three weeks or a month ago I had the honour of lecturing before the Royal Institution and the phonograph then being a greater novelty than it is now, I had been promised by Mr. Edison an instrument for exhibition, but knowing that inventors cannot always fulfil their promises as to time . . ." (he took the precaution of having one made according to Edison's description). So although this early model arrived too late to be shown at the Royal Institution, it appears that it eventually found a home here; our specimen is identical in every way with that figured in Preece's paper. Tinfoil is pressed on to the surface of the cylinder with a grease adhesive. If one shouts "Mary had a little lamb" into the mouthpiece of the sound box while turning the handle, this classical poem is distinctly repeated when the needle on the sound box covers the same track again.

William Spottiswoode, who worked in the publishing firm of Eyre and Spottiswoode, became a member of the Royal Institution in 1864. He was a great amateur scientist, who equipped his own laboratory on a lavish scale. His collection of optical and electrical apparatus was presented by W. Hugh Spottiswoode in 1899, on the occasion of the centenary of the Institution. Spottiswoode gave a discourse in 1873 on "The Old and New Laboratories at the Royal Institution", and this, together with a description of his collection of apparatus, was reprinted as a pamphlet. It is a mine of information. One interesting sidelight is the following story which Spottiswoode told: "It is said that Mr. Fuller, the feebleness of whose constitution denied him at all other times and places the rest necessary for health, could always find repose and even quiet slumber amid the murmuring lectures of the Royal Institution, and that in gratitude for the peaceful hours thus snatched from an otherwise restless life . . ." he left a legacy to the Royal Institution for establishing the Fullerian professorship, which I now have the honour of holding. I hope some members of my audience to-night will be similarly moved. Spottiswoode's apparatus is distinguished for its costliness and rarity, as if he were determined to have the best and largest of everything. In particular, his Nicol prisms and tourmaline plates exhibited here are outstanding.

In 1879 W. E. Ayrton gave a discourse on "The Mirror of Japan and its Magic Quality". These mirrors are Chinese in origin, and called "mirrors that let the light pass through them". The back has a pattern in heavy relief. The front is brightly polished and appears to be quite uniform. If, however, the light from a bright point source is reflected on to a screen by the mirror, the pattern on the back is faithfully repeated in the patch of light. The magic mirrors were known to antiquity (Ayrton says that they were described by Aulus Gellius in A.D. 100), though the origin of the magic property was a mystery. So late as 1832 Sir David Brewster believed it was due to trickery, a slight etching or scratching of the front surface having been made to correspond to the pattern on the back. The explanation of the effect was first put forward by Govi in 1864 as due to slight changes of curvature of the face. Ayrton, who had lived in Japan and had an opportunity of studying the manufacture of the mirrors, solved the mystery. The mirror is made slightly convex by scoring it in all directions with an iron rod before polishing, and the places where it is thick are less convex than those where it is thin, because there is less yield to the strain created by the scoring process.

Electrostatic machines, and the electrostatic discharge in evacuated tubes, aroused the deepest interest. The Royal Institution has a long series of electrostatic machines, from those of Nairne and Winter to a very large Wimshurst machine made by Wimshurst himself. The Spottiswoode collection includes a large hammer-break induction coil which gives a spark 17 in. long, and some hundreds of discharge tubes which are beautiful examples of glass-blowing. In these days of neon signs the phenomena of the discharge do not seem so strange to us as they did to former generations, but the excitation of these tubes by the Spottiswoode coil is still a very spectacular display.

An interesting 'gadget' from the United States depends upon the electrostatic discharge; it is an early form of gas lighter, presented to the Royal Institution in 1865. The advertisement (Fig. 2) shows how it works. The turning of the ebonite knob and its sudden removal induces a charge on the cup, which discharges across the sparking points just above the jet and so lights the gas.

The next three examples show stages in the development of the dynamo. The Clarke machine (Fig. 3*a*) has coils on a yoke which rotates opposite the poles of a composite horseshoe permanent magnet. In the next stage, shown in Fig. 3*b*, Siemens designed an armature of a more modern form, and shaped pole pieces, with a great improvement of the magnetic circuit, though permanent magnets were still employed. It was then realized that an electromagnet would provide a more powerful field-magnet,

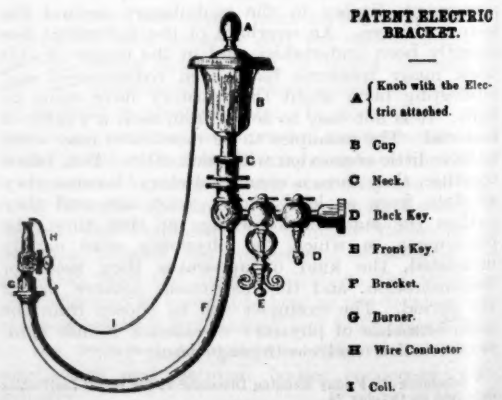
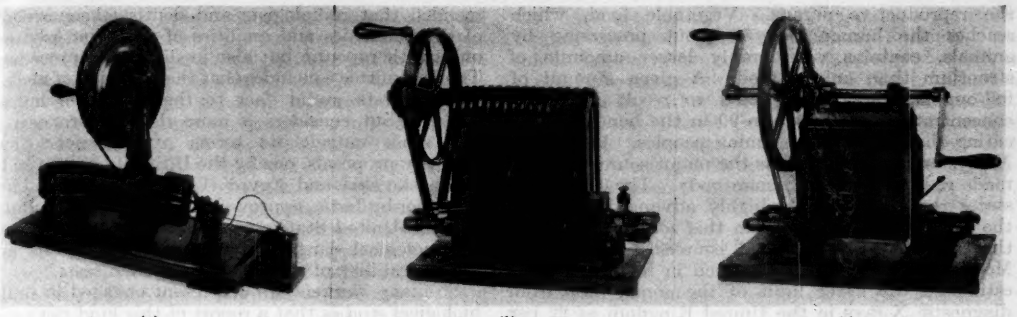


Fig. 2



(a) (b) (c)

Fig. 3

so a small dynamo with permanent magnets was mounted above the main dynamo and excited the field. In Ladd's machine, shown in Fig. 3c, the idea was taken one stage further; the armature has two windings, one to excite the field and one to provide the current. Finally, of course, it was realized that part of the main current from the armature could be diverted to exciting the field.

We appear to have no record of how my last exhibit reached the Royal Institution. It is a very early example of the use of microfilm, which we are accustomed to think of as a quite recent development. These samples date back to the siege of Paris in 1870–71. Messages could be got out of Paris by balloon, and attempts were made to get them back by carrier pigeon, but the pigeons were poorly trained and harassed by hawks and falcons sent up by the Prussians, so few got through. In its extremity, the Government called in the help of M. Dagron, who devised a way of photographing the messages greatly reduced in size and stripping the pellicle of film from the plate. Each pellicle had 3,000 letters on it, and a pigeon could carry twenty pellicles in a quill attached to its tail, so it was possible to repeat the messages almost indefinitely until reply came from Paris that they had reached their destination. So successfully did the system work that the public were allowed to use it at 50 centimes a word—a very interesting example of necessity being the mother of invention.

When one surveys the apparatus in the storerooms of the Royal Institution and thinks of the many great occasions in the past when they were shown at the discourses, one cannot but realize that this place, of which we are the trustees and guardians, is a national treasure house of a unique kind.

EFFECTS OF ATOMIC RADIATION

IN December 1955 the General Assembly of the United Nations set up a scientific committee for assembling, studying, and finally summarizing all available evidence on levels of ionizing radiation and radioactivity and their effects on man and his environment. The committee members were drawn from fifteen States: Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, Egypt (United Arab Republic), France, India, Japan, Mexico, Sweden, U.S.S.R., United Kingdom, and United States. A summary report was drafted during the fourth session of the committee in February 1958 and approved at its fifth session in June. It is based on 213 reports from member States and specialized organizations, such as the World Health Organization. Much use has obviously been made of the two extensive reports published in 1956 by the United States and the United Kingdom[1].

The report of the United Nations Scientific Committee consists of two parts*. The first, shorter, one contains summarizing chapters on physical data, fundamental radiobiology, somatic and genetic effects of radiations, and conclusions drawn from the available evidence. The second part presents the data and considerations which form the material for the first. It consists of a number of 'annexes', some with additional appendixes, all with extensive literature references and numerous tables and graphs, but differing in the amount of space allotted to discussion and speculation. Undoubtedly the most valuable feature of the report is the assemblage of world-wide tabulated data on all aspects of radiobiology: including physical aspects such as the amount of cosmic radiation, of fall-out, and of radium content of the water in many regions of the Earth, and biological aspects such as the estimated doses for doubling mutation-rates in various organisms, or the amount of strontium-90 and cæsium-137 adsorbed into the human body in different countries and under different nutritional regimes.

A considerable amount of data which appeared after the publication of the American and British reports had to be assimilated. The quantitative estimates of fall-out had to take account of the two facts that (*a*) some fission products of nuclear explosions do not reach the stratosphere and are brought down by rainfall and sedimentation from the troposphere, and (*b*) fall-out from the stratosphere varies with latitude, regions between 30 and 50° N. receiving a considerably higher deposition than the world-wide average. The estimates of damage from ingested radioisotopes are affected by data on the strontium–calcium balance in different soils and foodstuffs and by the recognition of cæsium-137 as an important isotope which, unlike strontium-90, is distributed fairly evenly through the body, including

* Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. (General Assembly—Official Records: Thirteenth Session, Supplement No. 17 (A/3838).) Pp. iii+228. (New York: United Nations; London: H.M. Stationery Office, 1958.) 2.50 dollars; 18s.; 10.50 Swiss francs.

the reproductive organs. Vegetable food, which reaches the human body without processing by animals, contains considerably larger amounts of strontium than animal food. A given amount of fall-out is therefore expected to result in higher concentrations of strontium-90 in the bones of rice-eating than of milk-consuming peoples. Diagnostic X-rays are still regarded as the major source of man-made radiation to the human body. The committee states that in medically highly advanced countries the average gonad dose from this source may equal that received from natural sources. The British Medical Research Council, which in its 1956 report estimated the lower limit of the gonad dose from diagnostic X-rays in the United Kingdom as 22 per cent of the background dose, has now revised this opinion[2]. In its detailed critical comment of the United Nations report, the British Medical Research Council accepts the statement quoted above, but points out that the world average must be much smaller. Certain types of examination, especially by fluoroscopy, give very high doses to the bone marrow. Less radiation is contributed by radiotherapy and very much less by occupational exposures.

In spite of these additions and alterations, the conclusions drawn from the data are essentially the same as those arrived at by the two national reports. After defining the 'genetically significant dose' as the average gonad dose to the individual weighted by the expected number of children, the Committee accepts "that radiation-induced mutations are, in general, harmful and increase in direct proportion to the genetically significant exposure, even at very low dose levels; and that a dose of between 10 and 100 rads (the rad is the unit of absorbed radiation: it is very close to 1 r.) per generation would probably be required to double the natural mutation rate in human populations". On the basis of calculations which the British Medical Research Council accepts only with certain reservations, the Committee estimates that about 4 per cent of all births are affected with hereditary disorders, and that a permanent doubling of the mutation-rate would increase this number to between 5 and 8 per cent. Estimation of the somatic damage is made difficult by ignorance of the precise dose-relationship between radiation and leukæmia, cancer, and other somatic effects, including ageing. Calculations have therefore been carried out separately for two alternative assumptions: the existence of a threshold below which the individual is not harmed by radiation, and a linear dose-effect curve like that found for mutations. These assumptions give different quantitative results, but in either case "it must be recognized that the exposure of human populations to increasing levels of ionizing radiations may cause considerable and widespread somatic damage". In regard to the possible shortening of the average life-span by radiation, the report is somewhat more reserved than the American one and restricts itself to the statement that such a shortening does occur in experimental animals, and that "it is possible that the same may be true for man". The Committee quotes recent British data indicating a correlation between, on one hand, leukæmia and other cancers in childhood and, on the other, irradiation of the fœtus, but points out that alternative interpretations cannot be excluded.

The practical recommendations are essentially the same as those in the two national reports. The introduction of individual radiation certificates is considered impracticable at present, but it is recommended that radiologists and dentists keep records of the quantities and qualities of radiation used not only in therapeutic but also in diagnostic procedure. The Committee concludes that the cessation of nuclear weapon tests would "act to the benefit of human health", but considers a more definite proposal in this sense outside its terms of reference. Two minority proposals, one by the U.S.S.R., approved by Czechoslovakia and Egypt (United Arab Republic), the other by India, approved by Brazil, France, Japan and the United States, are less reserved in stressing the biological dangers of nuclear weapon tests and the desirability of the cessation of such tests.

So many workers are at present engaged in radiobiological studies that a report of this kind can never be completely up to date. Among those recent results which could not be included, two may be singled out because of their potential significance for estimates of radiation hazards. One is the finding by Griffen[3] that males of a Bent-Tail strain of mice which had been given 700 r. of X-radiation produced a fair number of semi-sterile sons during their post-sterile period, presumably from irradiated spermatogonia. In one case, the semi-sterility was shown to be due to a translocation; for the remaining 25, cytological tests have not yet been carried out, nor is it clear whether the semi-sterile condition was transmitted to half the sons, as would be expected if it were in every case due to a translocation. In Griffen's opinion these data invalidate the current belief that the production of translocations in spermatogonia can be neglected in calculations of genetical radiation damage; but since this belief is founded on clear data, both in *Drosophila* and the mouse (including new unpublished results by W. L. Russell), it would seem better to reserve judgment until a full analysis of this surprising observation is available. The second important result which appeared too late for inclusion in the report is the observation by W. L. Russell and E. M. Kelly[4] that low-intensity gamma radiation (90 r. per week) produced fewer mutations in mouse spermatogonia than the same dose given in one intense exposure of X-rays.

Since this finding is likely to be used as an argument in the discussion of genetical radiation hazards, three points should be emphasized. First, even with low-intensity radiation, the per locus mutation-rate is still several times as high as that obtained by intense irradiation of *Drosophila* spermatogonia (Russell, personal communication). Secondly, the low-intensity test was carried out mainly because the dose-effect curve for high intensities had shown an unexpected depression at high doses, suggesting the disturbing possibility that the mutation-rate at very low doses or intensities might be *higher* than expected on a linear dose-effect relationship; this possibility could be ruled out by the low-intensity data. Thirdly, Russell cautions that, because of the nature of the material, it is at present difficult to predict what the dose curve will be like at still lower intensities of radiation. Thus, it is certainly not safe to conclude that the data support the concept of a threshold dose for genetic effects.

The three major reports on radiation hazards clearly are addressed to different sections of the reading public: the American report to the 'man in the street', the British to the general reader who is willing to spend time and effort on a thorough study of the whole question, the United Nations report to the expert. It is therefore doubtful whether the long and often highly speculative discussions of specialized

biological phenomena (such as the biochemical activities of mitochondria and microsomes; the effects of radiation on kappa particles in *Paramecium* and on prophage in lysogenic bacteria; the possible existence of mutator genes in human populations; and many others) are necessary or, indeed, helpful to an appreciation of the presented facts. The expert in a particular field will know the original literature. Others (for example, a physicist reading the sections about bacterial genetics) will scarcely be able to take in this wealth of information and speculation, let alone use it for the intended purpose, namely, as basis for a critical evaluation of radiation hazards. Limitation of the space devoted to discussion would also have avoided much tedious repetition and overlapping between chapters. These, however, are minor defects which probably will correct themselves through the reader skipping whatever does not interest him by being either too familiar or too unfamiliar. They do not detract from the high value of this impressive presentation of carefully collected and critically evaluated data and the considered judgments and recommendations based on them.

C. AUERBACH

[1] Auerbach, C., *Nature*, **178**, 453 (1956).
[2] Medical Research Council (H.M. Stationery Office, 1958).
[3] Griffen, A. B., *Proc. U.S. Nat. Acad. Sci.*, **44**, 691 (1958).
[4] Russell, W. L., and Kelly, E. M., *Science*, **127**, 1062 (1958).

IODINE-131 IN HUMAN THYROIDS FOLLOWING THE WINDSCALE REACTOR ACCIDENT

By G. MAYCOCK and J. VENNART
Radiological Protection Service, Belmont, Sutton, Surrey

DURING the latter half of October 1957, following the Windscale reactor accident, we observed that the gamma-ray activity of certain members of the staff of the Radiological Protection Service, at Belmont, Surrey, was higher than expected from previous estimates of their body content of the naturally occurring isotope of potassium, potassium-40 and the fission product cæsium-137. The source of the greater part of this increased activity was identified as iodine-131, which had not occurred previously in the gamma-ray spectrum of these individuals, and there was also evidence of a slight increase in the cæsium-137 content. However, since iodine is concentrated in the thyroid gland, whereas cæsium is distributed throughout the body, it was evident that, so far as radiation damage to the individual might be concerned, only the increased amount of iodine-131 would be important. We decided, therefore, to make some measurements of the iodine-131 in human thyroids. In view of the account of the Windscale reactor accident[1] and the recent paper by Stewart and Crooks[2] reporting the subsequent contamination by nuclear debris of many parts of England, we are reporting our measurements as a matter of interest, since few organizations will possess the equipment and the low-background laboratory which is essential for the measurement of the low levels of thyroid activity reported here.

The measurements were made in a low-background laboratory using a sodium iodide (thallium) crystal, 2 in. × 1·75 in. in diameter, optically coupled to a photomultiplier tube, the output of which was fed via amplifiers to a 100-channel pulse-height analyser. For the measurement of an individual, this crystal was arranged over the thyroid with the curved surface touching the skin. The equipment was calibrated with a known amount of iodine-131 in two polyethylene bottles having dimensions very close to that of the lobes of an average thyroid. The bottles were strapped, 6 cm. apart, on to the neck of a model of the human body containing distilled water so that the centres of the model lobes were 3 cm. below the proximal crystal surface. This particular dimension was used, since measurements by one of us (J. V.) on more than a hundred persons submitted for diagnosis of thyroid function using iodine-131 had shown that the mean effective depth of the thyroid below the anterior skin surface was approximately 3 cm. The space between the model lobes and the crystal was packed with polyethylene to give an approximation to the actual case of a human neck. Although a larger distance between the crystal and the neck would have minimized errors due to variations in depth of thyroid below the surface of the skin, the method used gave reasonable accuracy and it had the merit, with regard to the low levels expected, of giving maximum sensitivity.

The iodine-131 in the thyroid of an individual was then assessed by comparing the counting-rate within the 0·36-MeV. photo peak of his gamma-ray spectrum with the corresponding counting-rate in the spectrum of the model. An appropriate correction, which was very small, was made for the contribution from potassium-40 and cæsium-137 within the individual's body. Each individual was measured for a period of 15 min.; the standard deviation due to counting-background amounted to 0·04 mμc. iodine-131. An idea of the reliability of these measurements may be obtained by comparing our measurements on one individual, person *K* in Table 1, who was a visitor from Leeds, with that made by Burch and Spiers[3] at Leeds. They found that this individual had 8·2 mμc. of iodine-131 in his thyroid on October 31 and 8·8 mμc. on November 2. These values are in excellent agreement with our own measurement, which was 8·5 mμc. on November 1.

Eighteen persons were measured, the majority of whom were resident either in, or on the fringe of, the Greater London area. The exceptions were persons *B* and *L*, who were resident in mid-Surrey but working in Belmont, and person *K*, who was a visitor from Leeds. Apart from *F* and *G* (two children aged 12 and 10½ years, respectively) the group comprised both male and female adults.

It was not convenient to make more than one measurement in the case of most of these individuals, but where series of measurements were possible they are listed in Table 1.

Table 1. Iodine-131 Content of Thyroid (in mμc.)

Subject	Date of measurement							
	Oct. 1957	November 1957					Jan. 1958	
	31	1	4	5	8	15	22	2
A	2·6							
B	0·6							
C	1·8			1·5	1·0	0·7		
D	2·0					0·8		
E	2·1					0·2		
F	1·8							
G	1·3							
H		6·3		5·1	3·8	2·6	1·8	0·09
I		2·4			1·5			0·16
J		0·9						
K		8·5						
L		1·0						
M		1·2						
N		1·6	1·0					
O		1·4				0·3		
P			1·2					
Q				1·5	1·4	1·0		
R				0·6				

The results for the one person, *H*, on whom we were able to make a series of reliable measurements showed an elimination-rate from the thyroid which was slower than the radioactive decay-rate of iodine-131. This clearly indicates that the uptake of iodine-131 into the gland was continuing throughout the period of measurement. Since the atmospheric contamination of iodine-131 at the time of measurement was negligible[3], the only route of entry into human thyroids would be by ingestion, such as would result from the daily intake of milk obtained from cows grazing contaminated pastures. The fact that person *H*, who showed the highest value of iodine-131 in the thyroid for the London group, had by far the highest milk intake (at least two pints daily) also supports the view that the main source of iodine-131 was in milk. This is in agreement with the views expressed in the report of the accident[1]. Furthermore, we were able to detect iodine-131 in London milk during the period indicated in Table 1; but the activities were too low to state the amount with confidence.

All the persons listed in Table 1, apart from *K*, would have been drinking milk from a large London dairy during working hours, and all except *B* and *L* from one or other of the large London dairies while at home. The milk supply for the dairies comes from a wide area of the country around London.

In order to calculate the dose of radiation received by the thyroid, it is first necessary to know how the thyroid-level of iodine-131 varies with time after the event. Since the main route of entry to the human thyroid was via milk, then as the cloud with its iodine-131 from Windscale passed over Britain on October 11, we may expect that the first day on which milk contained this isotope was October 12. This is in agreement with the findings at Windscale reported by the committee of inquiry[1]. In the early days following the accident there might have been a period during which the activity in milk increased, since some delay would occur while the iodine-131 on the grass passes through the cow. When the level of iodine-131 in milk is in equilibrium with that on herbage, the activity in milk will decrease at a rate determined by radioactive decay and by other processes, for example, leaching by rain and decay of the vegetation. With regard to an estimation of the radiation-dose to the thyroid of a human drinking this milk, it is also necessary to consider losses of iodine-131 from the thyroid due to biological elimination and to radioactive decay. It is obvious, therefore, that the pattern of thyroid uptake and excretion may be very complex, especially during the early days after the accident. Our results relate to a period which begins several days after the accident, when we might expect the iodine-131 in milk had reached equilibrium with that on the grass. These results will therefore give no information about the pattern of the initial build-up in the thyroid. However, since our intention is to make an estimate only of the dose in the thyroid, the following simplification of the problem is permissible.

If we assume that the activity in milk decreases exponentially with time, and with the same decay constant, λ day^{-1}, as that for iodine-131 in the thyroid, then the amount of iodine-131 in the thyroid, q mμc., at any time, t days, after the initial ingestion, is given by the equation:

$$\frac{dq}{dt} = B \exp(-\lambda t) - \lambda q \qquad (1)$$

where B is the initial daily intake in mμc./day. Hence,

$$q \text{ (in m}\mu\text{c.)} = Bt. \exp(-\lambda t) \qquad (2)$$

The above assumption will be valid, and this equation will describe the pattern of uptake, and excretion, of iodine-131 from the thyroid if, for example, decrease of activity in milk and in the thyroid is principally by radioactive decay. Since the rate of biological elimination of iodine-131 from normal human thyroids is small[4], the effective decay constant in the thyroid will be only slightly greater than the radioactive decay constant of iodine-131, which is 0·087 day^{-1}. It is, perhaps, not surprising, therefore, that the results for person *H*, on whom the greatest number of measurements were made, can be fitted very closely (see Fig. 1) to equation 2 when $\lambda = 0{\cdot}1$ day^{-1}, $B = 2{\cdot}3$ mμc./day and t, in days, is measured from zero time, October 12.

By integrating the expression $Bt(\exp - \lambda t)$ over infinite time, it can be shown that the total thyroid dose of iodine-131 amounted to 230 mμc. days. Using values given in the Recommendations of the International Commission on Radiological Protection[4] for the effective energy per disintegration, 0·22 MeV., and the weight of the thyroid, 20 gm., it follows that the total mean radiation dose to the thyroid of person *H* due to the accident amounts to 0·13 rad.

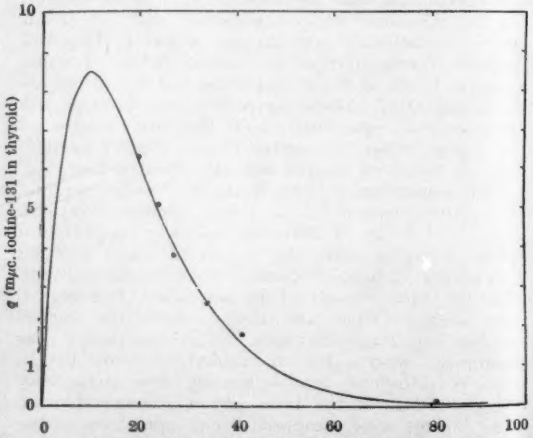


Fig. 1. Uptake and excretion of iodine-131 in human thyroid following the accident at Windscale. The curve represents the equation $q = 2{\cdot}3t \exp(-0{\cdot}1t)$; ●, experimental determinations on subject *H*

If we assume the same pattern of uptake throughout the group, then it is evident from the results in Table 1 that the average person in the Surrey and London groups received about one-third of this value, or 0·04 rad. The error, due to neglecting the possibility of initial 'build-up of activity in milk, should be small. An estimate of the upper limit of thyroid dose may be made by assuming—quite unrealistically with regard to the fact that milk contained iodine-131 at the time of the measurements—that this accident was due to a single intake of iodine-131 on October 11, when the main cloud passed over London. Then assuming that the half-period for decay thereafter was that expected for normal people[4], 7·5 days, since the mean level of iodine-131 in the London and Surrey group was about 2 mμc. on October 31, it may be shown that the total mean dose to the thyroid was 0·08 rad, or about twice that estimated by the more likely conditions above. The two children, *F* and *G*, had the same milk supply and were drinking about the same quantity of milk daily as person *N*. The similarity of the results for these three individuals suggests that there is little difference in the uptake of iodine-131 into the thyroid at different ages. Therefore, because of the different thyroid weights, the dose to the children's thyroids was twice that to the adult's.

The magnitude of the radiation dose to adult human thyroids in the London and Surrey people measured was therefore comparable with that expected each year from natural background radiation which, for example, amounts to about 0·1 rad per annum in Leeds[5] and about 80 per cent of this value in Sutton[6].

[1] Accident at Windscale No. 1 Pile on 10th October, 1957. Cmnd. 302. (H.M.S.O., 1958).
[2] Stewart, N. G., and Crooks, R. N., *Nature*, **182**, 627 (1958).
[3] Burch, P. R. J., and Spiers, F. W., University of Leeds (private communication).
[4] Recommendations of the International Commission on Radiological Protection, *Brit. J. Radiol.*, Supp. No. 6 (1955).
[5] Spiers, F. W., and Griffith, H. D., *Brit. J. Radiol.*, **29**, 175 (1956).
[6] Vennart, J., *Brit. J. Radiol.*, **30**, 55 (1957).

PROGRESS OF CANCER RESEARCH

THE current annual report of the British Empire Cancer Campaign for 1957* consists of a volume of more than 500 pages plus a supplement of 156 pages.

During the year the Campaign financed cancer research by grants of more than £600,000; the index of research workers mentioned contains nearly 1,100 names. Some idea of the type of research described in the report can be gained from Table 1, which divides up the different studies into a number of manageable groups. Any such classification is certainly liable to over-emphasize some lines of work and under-estimate the importance of others, but there seems no other way of indicating, however approximately, their relative attraction for those engaged in cancer research.

Table 1. THE RELATIVE NUMBER, VERY APPROXIMATELY, OF INVESTIGATIONS DESCRIBED IN THE ANNUAL REPORT OF THE BRITISH EMPIRE CANCER CAMPAIGN FOR 1957

Radiation therapy; radiobiology, radioisotopes	38
Carcinogens; carcinogenesis	29
Nucleoproteins	27
Biochemistry of tumours; cytochemistry and cytology	20
Hormones; steroids	19
Clinico-pathology	20
Chemotherapy	12
Viruses; fowl tumours	10
Immunology	8
Mutagens; genetics	8
Tissue culture	6
Demography; statistics	5
Smoking and lung cancer	5

This table presents a puzzling aspect of cancer research, for why is it that the most interesting topic to-day, namely, smoking and lung cancer, is at the bottom of the list and not at the top?

The report has the virtue of enabling the specialist to keep *au courant*, year by year, with what other workers in his field are doing; but for other kinds of reader the report will prove heavy going, for it resembles, more and more, a catalogue of highly technical abstracts on abstruse subjects. This difficulty of reporting cancer research has developed partly because financial and other facilities have increased very rapidly, the result being to encourage expansion, not directly on cancer but on subjects which are somewhat indirectly related to it and are more amenable to investigation.

A further function of a report such as this is the necessary one of showing that the many and various recipients of Campaign grants have used those grants to good advantage. To do this, it is arranged geographically, according to the place where the work is done, and not by subject. But it must be recognized that the scientific value of the volume is much diminished by this. How much more striking a survey of progress in cancer research this could be made if work in each field was gathered together in even the roughest of logical orders. If that is impossible, is it too much to ask again for a subject index?

The supplement (156 pages) to the report is by the veteran epidemiologist-statistician, Dr. Percy Stocks; it is an account of his monumental study, "Cancer Incidence in North Wales and Liverpool Region in Relation to Habits and Environment", and is composed of sections on local differences in death-rates; morbidity-rates; urban and rural residence; Welsh and Irish parentage; marital history; dietary histories; smoking and smoke; soil; other factors (use of oil lamps; use of petrol lighters; streptococcal infections; vaccination against smallpox; residence in house with vegetable garden); national and vital statistics.

An interesting line of approach to the problem of chemical carcinogenesis is the persistent effort by the Birmingham group under Orr to prove that the primary lesion in carcinogen-induced skin carcinoma in the mouse is in the dermis, not the epidermis. The great majority of serious attempts to explain cancer begin by assuming that the essential change occurs in the cells which are proliferating and invading—in the malignant cells themselves. Indeed,

* British Empire Cancer Campaign. Thirty-fifth Annual Report covering the year 1957. Part 1: The Chairman's Statement and the Accounts. Pp. xl. Part 2: The Scientific Report. Pp. xli+528. Supplement to Part 2: Report by Percy Stocks on Cancer Incidence in North Wales and Liverpool Region in Relation to Habits and Environment. Pp. iv+156. (London: British Empire Cancer Campaign, 1958.)

the phenomena of metastasis and transplantation, where malignant cells clearly establish themselves of their own initiative in normal tissues, can scarcely be explained otherwise. Yet there have been many who have suggested that the changes seen in the stroma around early carcinomata (they are often conspicuous, especially in skin tumours) are more important than those in the epithelium. There has been little except equivocal histological evidence for this view in the past, but the experiments of the Birmingham group put it on a firmer basis. Their principal earlier experiments were simply of this type: mouse skin was painted with methylcholanthrene in carcinogenic doses, and then, before tumours developed, grafts were exchanged between painted and non-painted areas. If the grafts were made of pure epithelium by the Billingham–Medawar trypsinization technique, more tumours appeared in areas where normal epidermis had been grafted to a painted site than where painted epidermis was grafted to a normal site. Though there are several possible sources of error in these experiments, *a priori* they indicated the possibility that stromal changes in the graft-bed were important. The newer experiments have similar implications. Pure epidermal grafts implanted subcutaneously with crystals of methylcholanthrene do not, they report, give rise to tumours. On the other hand, if pellets of methylcholanthrene are implanted subcutaneously into mice, removed after as little as two weeks, and replaced by a small Thiersch graft of skin, squamous carcinomata appear. Yet the amount of hydrocarbon remaining at the site of the pellet after its removal is far below a normal carcinogenic dose. The evidence that in these experiments some stromal change is a major factor in carcinogenesis would seem on the face of it to be hard to deny. However, ovarian transplantation experiments reported in another connexion from the same school, but involving the same principle, gave results less uncomfortably at variance with accepted theories.

It is noteworthy that none of the Campaign laboratories engaged in the cigarette–bronchial cancer problem has yet succeeded in producing tumours experimentally with any substances derived from tobacco; yet the statistical evidence for the association is further increased by several contributions.

The report of progress made at the Westminster Hospital towards a possible treatment of leukæmia by irradiation and marrow replacement is disappointingly brief. Three cases have had irradiation to ilea and upper femora, sufficient to suppress their marrow content, followed by grafts of normal marrow from donors injected into the lower abdominal aorta; steroids and nitrogen mustard were also given. It is reported that evidence of successful establishment of the homograft marrow was obtained in two cases.

Much work is in progress on the fashionable homotransplant-immunity theory of cancer; but judgment must be suspended on most of it for the present. One of the most interesting (though perhaps the one least directly related to cancer) is an admirable brief account of Billingham's work on the 'runt' disease of mice. It will be remembered that new-born mice injected with spleen cells of a donor strain become tolerant to grafts from the donor strain in later life, but that, with many strain combinations, the recipient mice fail to grow and show severe atrophy of all lymphoid tissues; this is thought to be due to an immune reaction by the donated graft cells against the host. In general, further experiments support this interpretation, but some discrepant findings have emerged. Buffy coat suspensions, which cannot be used for the passive transfer of homotransplant immunity, will produce runt disease. Bone marrow under some conditions can produce tolerance without runt disease, and experiments with F_1 hybrids have not altogether confirmed the results predicted.

The reports from physicists working on various forms of cancer research show that these workers fall into two main classes. In one group are those who concentrate on the physical aspects of biological problems and who are really becoming a race of biophysicists, and in the other are those who concentrate on improvements in the equipment and techniques used in this very wide field. These two main classes meet in the common field of radiation protection. The sensitive measuring techniques developed for this very essential service are now being put to investigating the various sources of natural radioactivity and its role in the possible production of malignant conditions.

One centre working on this problem has measured the natural radioactivity occurring in forty types of soils and fertilizers as well as hundreds of other environmental materials. A chalk pit has been excavated to form a low-activity counting area in which various substances including unprocessed milk have been assayed for isotopes such as cæsium-137 and iodine-131 which may be present. Theoretical studies have been made of the dosimetry of possible depositions of a beta-emitting isotope in bone. These calculations have been applied to the comparative dosage of radium and of strontium-90 when these elements are present under similar conditions. Total body counters are also being improved upon each year and a portable high-pressure ionization chamber has been developed which enables normal background dose-rates to be measured to an accuracy of $\pm$ 2 per cent in a measurement time of about 3 min. Studies of the 'rain-out' from tests of nuclear weapons exploded at Maralinga have been continued. Clear evidence of the presence of artificial radioactivity in rain 18 hr. after the explosions has been obtained. More definite information has been collected from measurements on rain which fell up to 14 days later.

Radioactive isotopes are now being widely used as a routine research tool, and many refinements of existing counting techniques are reported. Most of these modifications are designed to increase the sensitivity so as to enable lower levels of radioactivity to be used for *in vivo* studies. At the opposite end of the scale, large amounts of radioactive isotopes such as cobalt-60 and cæsium-137 are being used for the treatment of malignant diseases, and measurements have been made of the dosage distribution from a source of 1,150 c. of cobalt-60.

Reading this report as a whole leaves one with the impression that research in the field of cancer, as in most other fields, is becoming steadily more of a team project in which each member of the team needs to know a little of all the other aspects as well as a lot about his own. Physicists working on biological problems need to have a wide knowledge of biology, and biologists using physical techniques and methods nowadays require a grounding in physics to enable them to get the best interpretation of the data obtained using present-day equipment and to suggest possible modifications of such equipment for their particular problems.

OBITUARIES

Dr. Felix Oswald

Dr. Felix Oswald, a distinguished geologist and archæologist, died on November 3 on the ninety-second anniversary of his birth in 1866.

After gaining the degree of B.A.(London), Oswald entered the Civil Service. In his spare time, however, he made a study of geology, botany and zoology, and eventually presented these as his subjects for the B.Sc. degree examination, London, in which he gained first-class honours.

In 1898 he accompanied N. B. Lynch as geologist on a tour through Turkish Armenia. On their arrival at Lake Van, he made a careful investigation of the rocks and structure of the Crater of Nimrud, a volcano on the west shore of the lake. He later wrote "The Geology of Armenia" and presented it as his thesis for the degree of D.Sc.(London). As the cost of providing the requisite number of copies for the examiners proved prohibitive, he set up a press and printed 200 copies himself. The book had 600 pages and a number of coloured illustrations. He also made a geological map of Armenia and a coloured relief model of the Crater on the scale of 1 in. to the mile.

In 1907 he was elected a Fellow of the Geological Society of London. He also received from the Council of the Society an award from the Murchison Fund in recognition of his work in Armenia. In 1911 he went to Central Africa, on behalf of the British Museum, to investigate fossiliferous beds of Mid-Tertiary Age that had been discovered north-east of Victoria Nyanza. Four years later he was sent to the Caucasus in response to a request from the Russian Government for a geologist to search that region for additional sources of oil. In this work he was successful, and in addition produced a geological map of the Caucasus mountains.

Meanwhile, Oswald was appointed probate registrar for the East Midlands and accordingly moved to Nottingham. Here he became interested in Margidunum, a Roman station situated on the Fosseway. About 1911 he started excavating the site and continued until his retirement, in 1936, to Solva in Pembrokeshire. He built up a remarkable collection of pottery from the site. This is now housed in the museum of the University of Nottingham. He visited every important collection of Roman pottery in Europe. With the unrivalled knowledge thus gained, he produced several magnificent works on terra siggillata and many small ones, including detailed accounts of Margidunum. He won an international reputation, and even during his long retirement was visited and consulted by scholars from many parts of the world.

H. H. Swinnerton

Dr. Francisco Duran-Reynals

The death of Dr. F. Duran-Reynals, which occurred on March 27, 1958, deprived experimental pathology of one of its outstanding figures. Apart from many well-known studies of the role of viruses in the etiology of cancer, I particularly wish to record Duran-Reynals's influence—not so widely appreciated—in stimulating this field over many years less directly, and in encouraging developments which in turn have facilitated recent dramatic advances, particularly in the United States, in our knowledge of tumour viruses.

Francisco Duran-Reynals was born in Barcelona on December 5, 1899. After graduating from the University of Barcelona as M.D. in 1925, he then spent three years in work at the Pasteur Institute in Paris (with Profs. A. Besredka and E. Wollman), and (with Dr. J. B. Murphy) at the Rockefeller Institute, New York, to the staff of which he was appointed in 1928. In 1938, he became research professor at Yale University School of Medicine, with support from the Jane Coffin Childs Memorial Fund for Medical Research.

Duran-Reynals's earlier work was mainly concerned with the so-called ground-substance of the mesenchyme, and arose from the discovery of spreading factors—hyaluronidase and others—in mammalian testes (1928), bacteria (1933), snake venom (1936), and many other sources. His studies of viruses in relation to cancer date from 1938, and were continued to the end of his life, with much assistance from his wife, M. L. Duran-Reynals. These studies bore specially upon such aspects as virus variation and adaptation, antigenicity and epidemiology, and an important observation (of particular interest in relation to more recent discoveries) was of their maximal infecting power when injected into immature hosts.

Duran-Reynals was the recipient of many honours, notably (in 1952) the Anna Fuller Memorial Prize for Medical Research. His contributions not only to the above problems but also to many others in experimental pathology are embodied in upwards of a hundred papers, the last (1958) being a study of the infectious pulmonary adenoma complex in sheep.

In all he did he was not only scientist but artist as well. None who had the privilege to know him will soon forget his endearing qualities, his courage and gaiety, or his love of his native Spain.

A. Haddow

Dr. R. C. Fisher

Dr. Ronald Campbell Fisher was born on August 6, 1899, at Edinburgh, and died unexpectedly in his sleep on October 23. He was the elder son of Archibald W. Fisher, solicitor, and Catherine Dick Fleming. From George Heriot's School he proceeded to the University of Edinburgh, where he graduated in forestry in 1921 and was awarded the medals for advanced forestry and forest zoology. Following studies at Kew and Rothamsted on a research scholarship awarded by the Ministry of Agriculture and Fisheries, he received his doctorate for a thesis on forest insects in 1923.

After working for two years at the Imperial Forestry Institute, Oxford, Fisher transferred to the Forest Products Research Laboratory (Department of Scientific and Industrial Research) at Princes Risborough, as the first officer-in-charge of the Entomology Section. At that time, little was known of timber-boring insects in Great Britain, but during the thirty-one years he was in charge of this work,

he published, or was the co-author of, more than sixty papers and H.M. Stationery Office publications on this group of insects, and his staff published many more. His main contribution to the literature was the four papers which he published in the *Annals of Applied Biology* under the title of "Studies in the Biology of the Death Watch Beetle". These papers, and those of the late W. G. Campbell (officer-in-charge, Wood Chemistry Section, Forest Products Research Laboratory) on the nutritional aspects of this species, formed a basis for improved control measures in the light of the knowledge revealed on the association between death watch beetle attack and preceding fungal decay. For his paper on "Recent Work on Wood-Destroying Insects" he received a silver medal from the Royal Society of Arts. He read his last paper, entitled "Developments in the Control of Timber Insects", before the Society of Chemical Industry only three days before his death.

During his years at the Forest Products Research Laboratory, Fisher was constantly consulted on problems concerning wood-boring insect infestations, not only in timber, joinery and furniture, including many of the ancient buildings of historical interest in Britain, but also on infestations of tropical timbers. A physical disability had prevented him from following the career of a forest officer, but he retained a keen interest in the entomological problems of forest insects and in particular of the *Ambrosia* beetles. The post-war shortage of traditional timbers and demand for substitutes from among tropical species brought the *Ambrosia* beetle problem to the fore, and it was mainly due to his efforts that the West African Timber Borer Research Unit was set up by the Colonial Office in 1952. The supervision of the training of the staff of this unit and their research programme became one of his chief interests. He also served on H.M.S. *Victory* Technical Advisory Committee and on the committee set up by the Central Council for the Care of Churches. He was elected a Fellow of the Royal Society of Edinburgh in 1952.

He leaves a wife and two sons of whom the elder, Dr. R. Campbell Fisher, is studying insect parasites at the Entomological Laboratory, Belleville, Ontario, Canada, and the younger, aeronautical engineering at the University of Bristol. J. D. Bletchly

NEWS and VIEWS

Atoms for Peace Award : Prof. G. C. de Hevesy, For.Mem.R.S.

The second Atoms for Peace Award of 75,000 dollars and a gold medallion, founded as a memorial to Henry and Edsel Ford, has been made to Prof. G. C. de Hevesy, associate of the Institute for Research in Organic Chemistry, University of Stockholm, and of the Institute of Theoretical Physics, Copenhagen. In announcing the award, Dr. Detlev Bronk, president of the Rockefeller Institute for Medical Research and of the U.S. National Academy of Sciences, said that Prof. Hevesy was selected unanimously from 111 nominations for "his basic contribution to the peaceful uses of atomic energy in the discovery and development of tracer techniques in chemistry, biology, and medicine, using natural and artificial radioactive and stable isotopes for his continuing work in these fields". Prof. Hevesy is a Foreign Member of the Royal Society and was awarded the Copley Medal in 1949. He received the Nobel Prize for Chemistry in 1943.

United States Atomic Energy Commission : Dr. Frank K. Pittman

Dr. Frank K. Pittman has been appointed director of the Division of Reactor Development of the U.S. Atomic Energy Commission, and the functions previously assigned to the Office of Industrial Development have been transferred to that Division, except for those having to do with isotope development. The functions of isotope development will be undertaken by an Office of Isotope and Radiation Development with Dr. Paul C. Aebersold acting in charge.

Dr. Pittman graduated at Vanderbilt University and received his Ph.D. in inorganic chemistry from the Massachusetts Institute of Technology. He has been associated with the United States atomic energy programme since 1944, when he joined the staff of the Los Alamos Scientific Laboratory. He was in charge of plutonium production at the Laboratory until 1948. He has been director of the Office of Industrial Development since it was established in December 1957, and also had been serving as acting director of the Division of Reactor Development since August 5, following the resignation of W. Kenneth Davis.

Smith Kline and French Research Institute : Prof. W. A. Bain

Prof. W. A. Bain, who has held the chair of pharmacology at the University of Leeds since 1946, has accepted an invitation to become director of the Smith Kline and French Research Institute, and will resign his university appointment to take up this new post. After graduating in Edinburgh, William Alexander Bain became assistant to the late Sir E. Sharpey Schafer in 1928. In 1931, he was appointed lecturer in experimental physiology in the University of Edinburgh, before moving to Leeds in 1934, where he became, first, lecturer in physiology and later reader in pharmacology. Prof. Bain has conducted research on the autonomic nerves, on adrenaline and on the antagonists of histamine.

Laboratories for the Smith Kline and French Research Institute are under construction at Welwyn Garden City and are expected to be completed by the late summer of 1959. The research team which Prof. Bain will direct will form an important part of, and be complementary to, the extensive research effort of the parent company in Philadelphia. The Company believes that by having research teams both in Great Britain and in the United States there will be advantages to both by the interplay and exchange of scientific fact, opinions, outlook and approach.

Bell Telephone Laboratories : New Directors of Research

Dr. W. D. Lewis, of Mendham, and Mr. A. H. White, of Summit, have been appointed directors of research at Bell Telephone Laboratories, Murray Hill, New Jersey. Dr. Lewis will be in charge of

research on switching and transmission systems and techniques. Mr. White will be director of research in the physical sciences, including physics, chemistry, semiconductors, solid state electronics, metallurgy and materials. With Dr. J. R. Pierce, formerly director of research in electrical communications and now director of research in communications principles, Dr. Lewis and Mr. White will report to Dr. W. O. Baker, vice-president in charge of research.

Commonwealth Co-operation in Scientific Research

In the course of a speech on October 20 when opening the Esso Research Laboratories at Abingdon, the Lord President of the Council, Viscount Hailsham, referred to our comparative neglect of research as a nation, to which we devoted far too little of our resources, and emphasized the role of industry and the universities as well as of the Government. He said that in the view of the Government it was most important that there should be available in the Commonwealth, for those members who needed it, advice and assistance from other members including the United Kingdom, wherever these were available and funds could be found to meet it. Accordingly, the Government had announced at Montreal that, under the general control of the Committee of the Privy Council, an Overseas Research Council would be set up concerned with scientific research overseas, particularly in the Commonwealth (*Nature* of November 22, p. 1413). Our existing organizations in industrial, medical, and agricultural science would be available to give assistance through this new body, and he hoped new and fruitful scientific links would be formed in this way between Great Britain and members of the Commonwealth. Secondly, Lord Hailsham welcomed the attention which the United States was giving to research in the tropics, and particularly in Africa, as a fruitful field for Anglo-American co-operation (*Nature* of November 8, p. 1276).

The Institute for Strategic Studies, Ltd.

The formation of the Institute for Strategic Studies, Ltd., for the study of defence and disarmament has been announced. The Institute will be international, but the headquarters will be in London. Mr. Alastair Buchan, formerly defence and diplomatic correspondent and now assistant manager of the *Observer*, has been appointed director. The purpose of the Institute is to provide a focus for the study and discussion of the effects of political and scientific developments upon strategy, Western defence policies, and disarmament plans. It is also intended to develop a reference centre. The Ford Foundation in New York has made a grant of 150,000 dollars to finance the Institute for the first three years.

The founder members of the council of the Institute are: Sir Kenneth Grubb (chairman, Commission of the Churches on International Affairs) (*chairman*), Mr. Richard Goold-Adams (*vice-chairman*), Lord Salter (*honorary treasurer*), Prof. P. M. S. Blackett (professor of physics, Imperial College of Science and Technology), the Rev. Alan Booth (secretary, Commission of the Churches on International Affairs), Rear-Admiral Sir Anthony Buzzard (director, Vickers-Armstrongs, Ltd.), Air Chief Marshal Sir Ronald Ivelaw-Chapman, Lieutenant-General Sir John Eldridge, Mr. Kurt Hahn (former headmaster, Gordonstoun and Salem Schools), Captain B. H. Liddell Hart, Sir William Hayter (warden of New College, Oxford), Mr. Denis Healey, M.P., Mr. Michael Howard (lecturer in war studies, King's College, London), Sir James Hutchison, M.P., Lord McNair, Marshal of the R.A.F. Sir John Slessor, Sir Henry Tizard, Mr. Donald Tyerman (editor of the *Economist*), Canon H. M. Waddams (secretary, Church of England Council on Foreign Relations), Lord Weeks, and Mr. C. M. Woodhouse (director-general, Royal Institute of International Affairs). The Institute will also have an international advisory committee on strategy, defence, and international affairs throughout the Free World.

Committee of Public Accounts: Report for 1957–58

In its third report for the session 1957–58 (pp. 32. London: H.M. Stationery Office, 1958. 1*s*. 6*d*. net) the Committee of Public Accounts admits that the evidence given to the Committee last session regarding the cost of construction of the Jodrell Bank radio telescope was gravely inaccurate and misleading. The accounting officer now states that he is satisfied, after discussing the matter with the University of Manchester, that there was extensive consultation between the consultant engineers and the professor in charge on questions of design. There was, in fact, the fullest collaboration on scientific and technical matters between the consultants and the professor, and accordingly the concern expressed by the Committee in its third report for the session 1956–57 is essentially unfounded. It is, however, still not satisfied with the financial control exercised over this scheme, either by the Department or by the University, and welcomes the Treasury minute on its previous report indicating that steps are being taken to ensure close control by both the university and the Government department concerned in any future case of this kind. The Treasury has now authorized payment of an additional grant of £130,000, making a total of £560,000, and the Committee welcomes the assurance that the balance of the expenditure for the construction of the telescope will be found from other sources by the University (*Nature*, November 29, p. 1484).

United States Euratom Agreement

An agreement for co-operation in the civil uses of atomic energy between the United States and Euratom was signed on November 8 in Brussels. The major objective of the agreement is to bring into operation in the Community in the next five to seven years approximately one million electrical kilowatts of nuclear power capacity, using reactor types developed in the United States. It is expected that the provisions for wide dissemination of information under the programme will provide industrial organizations in the Community and the United States with valuable engineering experience, and technological and economic data concerning the operation of nuclear power plants in Europe under conditions that will be nearly competitive with conventionally fuelled plants. The capital cost of the joint nuclear power programme, exclusive of fuel, is expected to be about 350,000,000 dollars. An integral part of the programme is a joint ten-year research and development project. During the first five years the Community and the United States will each contribute up to 50,000,000 dollars. Before the expiration of the first five years the participants will determine the financial requirements for the remaining five years and will undertake to procure the necessary funds for the programme.

Committee on Space Research

At its recent meeting in Washington the International Council of Scientific Unions established a Committee on Space Research (COSPAR), with the primary purpose of providing a means whereby the scientific community may use to maximum advantage the possibilities of satellites and space probes for scientific purposes, and exchange the results on a co-operative basis. On November 14 and 15 the Committee on Space Research held its first meeting in the rooms of the Royal Society in London. A constitution was drawn up for approval by the International Council of Scientific Unions, and the following executive committee was elected: *President*, Prof. H. C. van de Hulst (International Astronomical Union); *Vice-Presidents*, Prof. E. K. Fedorov (U.S.S.R. Academy of Sciences, Moscow), Prof. W. Albert Noyes, jun. (University of Rochester, New York); *Members*, Prof. Maurice Roy (International Union of Theoretical and Applied Mechanics), Prof. H. S. W. Massey (International Union of Pure and Applied Physics).

National Science Foundation Grant for U.S. National Observatory

The National Science Foundation has allocated 4 million dollars to the Association of Universities for Research in Astronomy, Inc. (AURA), for the construction of a solar telescope. These funds bring to a total of 7,545,000 dollars the amount that has been allocated so far for the erection and operation of a United States national astronomical observatory on Kitt Peak in the Quinland Mountains of south-western Arizona (see *Nature*, **181**, 236; 1958). An additional 1 million dollars has been appropriated by Congress to the National Science Foundation for transfer to the Bureau of Public Roads for construction of a road giving access to the observatory site, which has been leased from the Papago Indians, in whose reservation it lies.

The solar telescope will be equipped with an 80-in. light-gathering flat at the top of the tower, and a 60-in. image-forming mirror, with a focal length of 300 ft. The instrument will thus be the largest solar telescope in existence, with about twice the focal length of the famous 150-ft. tower telescope at Mount Wilson. Stellar instruments at the observatory will consist initially of a 36-in. reflecting telescope to be made by Boller and Chivens, of South Pasadena, California, and an 80-in. high-speed reflecting telescope by Corning Glass Works, with auxiliary instrumentation.

Lunar Topography: Gift to the University of Manchester

The Geophysics Research Directorate of the U.S. Air Force, Cambridge (Mass.) Research Center, entered, as from November 1 of this year, into a contractual arrangement with the University of Manchester (through the European Office of the Air Research and Development Command in Brussels) to support in its Department of Astronomy an extended programme of topographic studies of the Moon. This emphasizes the current need for more accurate information on the heights and dimensions of lunar surface features than we possess to-day. A large part of such data as are now available go back to the work of amateur astronomers of the nineteenth century, and are based on visual measurements the accuracy of which leaves much to be desired. The Department of Astronomy at Manchester, under Prof. Zdeněk Kopal, proposes to increase this accuracy by filming sunrise or sunset over selected lunar regions, and triangulating for the topographical details of the landscape from measurements of the varying lengths of the shadows. This work was actually commenced two years ago by collaboration between the University of Manchester and the Observatoire du Pic-du-Midi in the High Pyrenees, which is well known for its superior seeing, and the photographic work done through the 24-in. refractor of the Observatory by kind permission of the director, Dr. Jean Rösch. The measurements and reductions of all films are to be made at Manchester under the supervision of Dr. Gilbert Fielder.

The ciné technique, pioneered by R. R. McMath, R. M. Petrie and H. E. Sawyer at the University of Michigan in the middle 1930's, has been elaborated in recent years at Manchester and has attained new standards of precision; its application to the Pic-du-Midi photographs makes it possible now to distinguish, on the Moon, objects of linear dimensions in excess of 500 yd., and altitude differences of the order of 20–30 yd. The programme of mapping the entire visible hemisphere of the Moon to this accuracy will probably occupy the Department of Astronomy at Manchester for the next five years, at a total cost of approximately 80,000 dollars.

Rowan Hamilton Bridge

On November 13, Mr. Eamon de Valera, Prime Minister of the Republic of Ireland, unveiled a tablet on Broome Bridge at Cabra, Dublin, to commemorate the invention of quaternions. The bridge has now been renamed Rowan Hamilton Bridge. The story of Hamilton and his bridge ranks with those of Archimedes and his bath and of Newton and his apple, as the Provost of Trinity College (Dr. A. J. McConnell) remarked in his speech at the ceremony, and it concerns a man of comparable intellectual stature. On October 16, 1843, Sir William Rowan Hamilton was walking with his wife along the Royal Canal from Dunsink Observatory to preside at the Council of the Royal Irish Academy when, on coming to Broome Bridge, the long-sought fundamental rules for quaternion algebra flashed upon his mind. Acting upon what he afterwards called an "unphilosophical impulse", he scratched the formulæ on the stonework with his penknife. The same afternoon he gave notice of his intention to read a paper on the subject at the Academy meeting on the following November 13—hence the date chosen for the unveiling. The tablet was erected by the Council of the Dublin Institute for Advanced Studies, of which the Right Rev. Monsignor P. Browne is chairman. Mr. de Valera, who is himself a mathematician well versed in Hamilton's work, has taken a keen personal interest in the project, which was carried on under the active direction of Prof. F. E. Hackett, chairman of the Governing Board of the School of Theoretical Physics of the Institute.

Hamilton's work on quaternions had widespread influence upon the development of mathematics, especially in America, and it was a pioneering step towards the subsequent far-reaching enlargement of algebra. While it is Hamilton's work in other fields that has had such a profound influence upon the whole form of modern theoretical physics, it would be scarcely possible to find in it, or in the work of any other theorist, anything more apt or evocative for a public memorial than the episode that has now

been commemorated. The memorial in Dublin may be unique as one commemorating a particular discovery in mathematics, and must surely be unique as one inaugurated by the head of a Government who personally appreciates the significance of an achievement of this kind.

British Museum (Natural History): The Hedges Collection of British Moths

Among the more important acquisitions recently reported to the Trustees of the British Museum (Natural History) was the Alfred Vander Hedges collection of British moths presented by Mrs. Celia Hedges, in accordance with the wish of her late husband. The collection is a very extensive one, comprising about 20,000 specimens, and consists almost exclusively of specimens reared in captivity by Mr. Hedges. Some of the specimens had been reared in experiments in connexion with genetical studies in co-operation with the late Dr. E. A. Cockayne, whose collections are already the property of the Museum. Others are the result of his intensive collecting in the Isle of Man, as a consequence of which many species previously unknown in that Island were discovered to be present. The whole collection is in the most perfect condition.

The National Trust

The sixty-third annual report of the National Trust presented to the annual meeting on November 7 records a further increase of membership to 70,687 during the first five months of the year, but the figure is still short of the 100,000 the Council hopes to reach by January 1960, and only a membership consonant with its responsibilities can enable the Trust to exert its full influence for the preservation of the best of the countryside and Britain's finest buildings. The report refers to the need to dispel widespread misapprehension arising from the title 'National Trust', which tends to obscure the Trust's dependence on voluntary support. Emphasis is also placed on the changes in method which the Trust has had to adopt now that it is increasingly concerned with the impact of the public on the countryside. Its duty has often become one of control to preserve the countryside from damage by litter hooliganism or even the sheer wear of numbers on a limited area. The Trust has had to face unpopularity in some quarters in confining the public to footpaths on agricultural land, in strictly limiting caravans, tents and car parks to appropriate sites, and generally in regulating access to its open spaces. Certain changes in the administration of the Trust are being made in accordance with the recommendations of a special committee appointed to consider the subject, and the first regional secretary has been appointed. The Trust's nature reserves continue to prosper and are becoming increasingly important. The new mere at Wicken Fen has already attracted a large variety of ducks and waders; the eider is again breeding in the Farne Islands in ever-increasing numbers and 600 pairs of Sandwich terns are known to have nested at Blakeney, while figures for redshank and little tern were also well above the average.

Forest Products Statistics

With the completion of the decade of publication of the Yearbook of Forest Products Statistics, the Forestry Division of the Food and Agriculture Organization of the United Nations has decided that in view of the considerable progress that had been achieved in making the compilation more complete, more uniform and more accurate, it would be of value to revise the earlier issues, bringing the data as nearly in line as possible with the latest, and to publish a ten-year summary. The particular value of such a summary (World Forest Products Statistics: a Ten-Year Summary, 1946–1955. Pp. viii+197. Rome: Food and Agriculture Organization; London: H.M. Stationery Office, 1958. 15*s.*; 3 dollars) lies in its use for the study of trends, which have become so important with the rapid developments in production and use of timber in most parts of the world.

This development is continually in progress and is exemplified in the Yearbook for 1957 (Pp. vi+169. Rome: Food and Agriculture Organization; London: H.M. Stationery Office, 1957. 12*s.* 6*d.*; 2 dollars) by the provision of separate statistics for particle board (defined as a board "constituted from fragments of wood and/or other vegetable materials which have been comminuted and then consolidated by pressure, heat, etc., with or without binders and supplementary materials"). World production of these materials rose from less than 500,000 metric tons in 1955 to 705,000 metric tons in 1956, more than half being in the United States and Germany, and there is every indication that there will be continued expansion in the future; there are factories in the United Kingdom, but the total output is still small. Another change in this issue is the inclusion of estimates for the relatively few countries from which returns have not been received; without these, regional totals can be very misleading.

Progress in Geology

The present century has, perhaps, been more notable for advances in techniques and in the accumulation of detailed knowledge than in the formulation of radically fresh ideas in geology, and it is of interest to inquire what general trend is discernible in the interpretation of the Earth's history as a result of these advances. Prof. L. Hawkes, in his anniversary address to the Geological Society of London (*Quart. J. Geol. Soc.*, **133**, 309; 1958), considers that vindication of the Lyellian doctrine of uniformitarianism has been the central theme of progress in geology in the past fifty years. During this period determination of the age of minerals by radioactive decay methods has underlined the immensity of the geological time-scale. At the same time, precise geodetic measurements have disclosed crustal movements in various parts of the world to-day proceeding at rates which, bearing this time-scale in mind, are adequate to account for the huge deformations of the past, thus extending the principle of uniformitarianism to the field of tectonics. Not only must earlier ideas on the catastrophic nature of mountain-building processes be discarded, but the presumed world-wide synchronism of mountain-building periods may also be seriously challenged as isotopic methods of dating and correlating sediments are improved. There may be no 'pulse of the Earth'. Normal sedimentary rocks were being formed at least 3,000 million years ago, and there is now direct fossil evidence for the existence of simple forms of life more than 2,000 million years ago. Conditions on the Earth's surface seem to have been much the same as they are to-day over a much longer span of time and in more ways than would generally have been believed possible fifty years ago.

Science Masters' Association

The annual meeting of the Science Masters' Association is to be held in University College, Gower Street, London, W.C.1, during December 30–January 2. The programme includes the following lectures: "The Scope of Modern Physics", by Prof. H. S. W. Massey; "Principles of Organic Chemistry", by Prof. E. D. Hughes; "Algal Pigments", by Dr. G. E. Fogg; "Industrial Applications of Radioisotopes", by J. L. Putman; "Learning in Octopuses", by Prof. J. Z. Young; "Opportunities for Students in Colleges of Technology", by Dr. J. Topping; "Old Metals and New Valencies: the Stabilization of Unusual Valency States", by Prof. R. S. Nyholm; "Techniques in Nuclear Physics", by Dr. E. H. S. Burhop; "New Engineering Problems in Aeronautics", by H. G. Conway; "The Study of Ripples by the Schlieren Method", by W. Llowarch; "Molecular Spectra and Molecular Structure", by Dr. D. J. Millen; "Some Problems in Teaching Science in Large Secondary Schools", by R. J. Scammell. Accommodation for members at the meeting will be provided at Queen Elizabeth College, Kensington, W.8; Canterbury Hall and Bentham Hall, both in Cartwright Gardens, W.C.1. Further information can be obtained from the annual meeting secretary, Mr. W. H. Dowland, 93 Westbourne Road, West Hartlepool, Co. Durham.

Imperial Chemical Industries Transfer Scholarships

Last year, thirty-three university students who decided that they wanted to change from the arts to science were able to do so by taking advantage of the Imperial Chemical Industries transfer scholarship scheme. Most of these students have now passed their examinations and have entered their chosen science honours school. Of the twenty-seven transfer scholars elected in 1956, more than 80 per cent successfully made the change from arts to science. These encouraging figures have persuaded Imperial Chemical Industries to extend its guarantee of scholarship funds for a further two years to the universities which originally co-operated in the scheme. These are Oxford, Cambridge, Liverpool, Imperial College of Science and Technology, London, and King's College, Newcastle. At Oxford the number of scholarships available will be extended so that, in common with Cambridge, every college will have a transfer scholarship in its gift. Scholarships not taken up can be passed on to other colleges which have more than one suitable candidate. In all, sixty-five of these scholarships are now available, the universities co-operating also including Birmingham, Bristol and Sheffield, which came into the scheme a little later.

University News: Belfast

The following appointments have recently been made: Dr. C. L. Wilson, to a personal chair in analytical chemistry; Dr. R. B. Welbourn, to a personal chair in surgical science; Dr. P. J. B. Clarricoats, to a lectureship in light electrical engineering; Dr. P. C. Elmes, to a lectureship in therapeutics and pharmacology.

London

The following have been appointed to University readerships in the subjects indicated: Mr. J. R. D. Francis, lecturer at the Imperial College of Science and Technology (fluid mechanics); Dr. R. W. Tiffen, lecturer at Birkbeck College (applied mathematics); Mr. W. J. Tulley, lecturer at Guy's Hospital Medical School (orthodontics). Dr. Emrys Jones, lecturer in geography at the Queen's University of Belfast, has been appointed to the University readership in social geography tenable at the London School of Economics and Political Science.

Announcements

The Christmas Lecture arranged by the Institution of Electrical Engineers will be held in the Institution's rooms on December 31, at 3 p.m., when Dr. E. R. Laithwaite (University of Manchester) will speak on "Invention and New Machines". Admission to the Lecture is by ticket, obtainable, free of charge, from the Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2.

The annual Christmas lectures organized by the Royal Photographic Society for a juvenile audience, which will be given in the Department of Photography at the Regent Street Polytechnic, London, W.1, at 2.30 p.m. on January 1 and 2, 1959, will be on "Picture Making in Photography". Tickets are free, and can be obtained on application to the Secretary of the Royal Photographic Society, 16 Princes Gate, London, S.W.7.

The annual conference of the Geographical Association will be held in the London School of Economics, Houghton Street, London, W.C.2, during December 30, 1958–January 2, 1959. Further details can be obtained from the honorary conference organizer, Mr. R. C. Honeybone, University of London Institute of Education, Malet Street, London, W.C.1.

The Palaeontological Association will hold a discussion meeting on "Micro-palaeontology" in the Department of Geology, Sedgwick Museum, Cambridge, on December 12 and 13. Sixteen papers on spores, ostracods, conodonts and foraminifera will be read, and there will also be a large number of exhibits. Further information can be obtained from Dr. Gwyn Thomas, Department of Geology, Imperial College of Science and Technology, London, S.W.7.

The Physical Society is organizing a conference on "Problems of Collective Motion", to be held at the University of Birmingham, on January 2 and 3, 1959. Informal discussions will follow introductory talks on gaseous plasma; plasma problems in the electron theory of metals; liquid helium and superconductivity; and collective problems in nuclear dynamics. The conference is open to non-members of the Physical Society on payment of a fee of one guinea. Further information can be obtained from Miss E. Mills, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

The following scholarships will be offered by the Institution of Naval Architects for competition in 1959: Denny Scholarships in Naval Architecture and Naval Engineering: £175 per annum, tenable for four years at the University of Glasgow, and open to British subjects less than nineteen years of age who have not yet begun an apprenticeship, or served not more than one year of it with Messrs. William Denny & Bros., Dumbarton. Parsons Scholarship in Marine Engineering: £175 per annum, open to British apprentices or pupils in marine engine works or the Royal Dockyards less than twenty-one years of age. Yarrow Scholarship in Marine Engineering: conditions as for Parsons Scholarship in Marine Engineering. Further particulars can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

THE COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, AUSTRALIA

CONSTITUTED in 1926 by Act of the Australian Parliament, the Council for Scientific and Industrial Research grew steadily and, in 1949, its name was changed to the Commonwealth Scientific and Industrial Research Organization. This led to little change in its policy and methods of work, the Organization being divided into a number of Sections and Divisions, each of which enjoys a large measure of autonomy in the conduct of its scientific programme. The Divisions and Sections cover a very wide field of scientific activity with the exception of atomic energy and human medical science; considerable activity is directed to veterinary science. The Organization is not a Government department, but is a Government 'instrumentality' which draws approximately 80 per cent of its revenue directly from the Treasury. The remainder is provided by other Commonwealth 'instrumentalities', such as the Snowy Mountains Authority, and certain industrial groups which finance investigations of interest to these bodies.

The work of the various Divisions and Sections is reflected in a remarkable series of publications, each of which does credit to an Organization which is very well administered and is doing so much for the development and spread of scientific inquiry throughout the southern hemisphere. These publications include journals, bulletins, technical papers, monographs, land research series and soil publication series.

Among the more special journals are the *Australian Journal of Physics*, the *Australian Journal of Chemistry*, the *Australian Journal of Applied Science* and the *Australian Journal of Biological Sciences*, each of which is issued quarterly; the *Australian Journal of Agricultural Research* is published six times a year. Not issued at regular intervals are the *Australian Journal of Marine and Freshwater Research*, the *Australian Journal of Botany* and the *Australian Journal of Zoology*. The *Journal of Biological Sciences* differs from the *Journals of Botany* and *Zoology* in paying more attention to the experimental sciences; the botany and zoology journals are more concerned with the descriptive phases.

The Australian Academy of Science co-operates with the Organization in maintaining appropriate standards in the eight journals mentioned above, and the journals are open to receive contributions from research workers, irrespective of country or of the establishment to which they are attached.

In a recent issue of the *Journal of Biological Sciences* (10, No. 4), for example, articles were included dealing with the physiology of pea fruits, with special reference to changes in sugars and phosphate compounds in the developing seed; the effects of auxins on the binding of pectin methylesterase to cell-wall preparations; the lag period in auxin-induced expansion of storage tissue and coleoptiles; the effect of developing embryos on plant viruses; studies on the seed transmission of plant virus diseases; the metabolism of *Ascaris lumbricoides* ovaries; the dose response to bovine plasma albumin in mice and the simulation of genetic systems by automatic digital computers.

A recent volume of the *Journal of Botany* (5, No. 2) contains descriptions of floral histogenesis in the Cyperaceae; the regeneration of severed pea apices; the soil moisture patterns produced by rainfall interception and stem-flow in Dark Island heath; the high mountain vegetation in Australia; and the nature and distribution of rain-forests in New South Wales.

The *Journal of Agricultural Research* is a medium for the publication of investigations relating to plants, soils and domestic animals, covering the physical, chemical and biological aspects in this field. Examples of the wide range of topics investigated is shown by a list of topics taken from a number published some months ago (8, No. 6). The topics included air-tight storage of grain and its effects on insect pests; the pruinose scarab (*Sericesthis pruinosa* Dalman) and its control in turf; the renovation of *Phalaris* pastures with special reference to nitrogen and sulphur relationships; quantitative inheritance in lucerne with particular reference to winter yield; a comparison of three low-persistence viruses of the strawberry; the effect of volatile fatty acids, lactic acid, and ammonia on rumen *p*H in sheep; the effect of diet on individual volatile fatty acids in the rumen of sheep, with particular reference to the effect of low rumen *p*H and adaptation of high-starch diets; the tolerance of sheep to sodium chloride in drinking water; a study of wool production per unit area of skin in Australian merino sheep; the equatorial light environment and its effect on the coat of European cattle; reactions of calves to infestation with the stomach worm; strategic dipping for control of the cattle tick, *Boophilus microplus* (canestrini), in south Queensland; and sperm transport in the fowl.

The *Australian Journal of Applied Science* is, as the name suggests, concerned with the publication of results of original investigations in the broad field of applied science. A recent issue (8, No. 4) contains articles dealing with edge stresses in thin shells of revolution; precision charge comparison for the standardization of X-ray dosimeters; heating of surfaces by buried pipes; heat transfer to liquids boiling inside tubes; an improvement of the vacuum vapour pump with theoretical and practical consequences; laboratory pressure-leaching techniques; slagging of refractories by brown coal ash; and a study of the infra-red absorption spectra of soils.

Besides these more 'formal' journals, the Organization issues a number of other publications dealing with applied researches into particular materials or topics. The Food Preservation and Transport Division, for example, publishes a quarterly journal in which the results of practical investigations of immediate topical interest are set out. The use of various plastic materials for pre-packaging fresh fruit and vegetables, for example, was investigated in 1957, and firm recommendations were made which would be of value not only to those in the trade but also to housewives. Other topics investigated by the Division in recent years include the internal corrosion of food cans; anthocyanin pigments in foods; glass-like deposits in canned foods; the

quality of dried-egg products; the handling and care of fresh unfrozen fish; discoloration of canned pears; and the estimation of dissolved tin and iron in canned foods.

The Coal Research Section also produces its own journal containing articles of direct value to those particularly concerned with the large-scale use of coal or its products. Besides articles describing the mineral matter in Australian coals and how coke is formed, the May 1958 issue contains the report of a symposium called to consider how iron castings in foundries could be improved through the use of improved qualities of foundry coke. Articles in other issues of the same journal describe the sulphur minerals in various Australian coals, the methods of cleaning coal and the industrial possibilities of Australian coal tars.

That the Organization is genuinely concerned to see that the results of its many researches are widely disseminated as quickly as possible is shown by two other publications. The Forest Products Division publishes a monthly news-letter which is available to all members of the timber trade and timber users. Topics discussed in some of the latest letters include "How Strong are Wooden Fence Posts?", the right Australian timbers to use for making clothes pegs, water-borne preservatives for fence posts, and low-pitch roof trusses.

The Agricultural Research Liaison Section produces a most attractive periodical called *Rural Research in C.S.I.R.O.*, which provides a summary of recent research and explains its practical significance. Among subjects which have been dealt with over the past year are the following: Kimberley horse disease; inbreeding merinos; tolerance of sheep to salt; plant nematodes; renovating *Phalaris* pastures; preserving fence posts; making clouds rain; crops and pastures for northern Australia; time losses in haymaking; scrapie in imported sheep; rabbit control in New Zealand; durable pleats in wool; damage of rice by ducks; the sheep blowfly; roundworms of cattle; 'snorter' dwarfism; changes in pasture soils; soil salinity; the portable soil-moisture meter and the spear grass problem.

Under the able chairmanship of Sir Ian Clunies Ross, assisted by the deputy chairman, Dr. F. W. G. White, and the vigorous executive direction of Dr. S. H. Bastow, the Commonwealth Scientific and Industrial Research Organization has already gathered sufficient momentum to ensure its ever-increasing usefulness in solving the many physical and biological problems which confront Commonwealth countries in the southern hemisphere.

Dr. N. S. Noble, general editor, is to be congratulated on the standard and style of the Organization's publications.

PULP AND PAPER RESEARCH INSTITUTE OF CANADA

NEW LABORATORIES

THE new laboratories of the Pulp and Paper Research Institute of Canada at Pointe Claire, Quebec, were officially opened on September 18 by the Hon. William Hamilton as representative of the Government of Canada. Other speakers included Dr. Lincoln R. Thiesmeyer, president of the Pulp and Paper Research Institute of Canada; Dr. David L. Thomson, dean of the Faculty of Graduate Studies and Research of McGill University; and Mr. Fred L. Allen, executive vice-president of the Canadian International Paper Company and chairman of the Institute's board of directors.

Few people employed in the pulp and paper industry of the world, be it in mill management or research, can fail to become aware at a very early stage of their career of the importance of both the fundamental and the applied research carried out at the Pulp and Paper Research Institute of Canada, the research institution jointly sponsored by the Canadian Government, the pulp and paper industry of Canada as represented by the Canadian Pulp and Paper Association, and the Royal Institution for the Advancement of Learning of Canada.

The Institute started as a branch of the Forest Products Laboratories of Canada in 1913, and in its early years was housed in part of two old buildings at the corner of the McGill campus. In 1920 the Canadian Pulp and Paper Association joined its own research activities with those of McGill and the Government and soon the rate and scope of the research activities made larger buildings necessary; these were built on the same site and opened in 1929. In 1940 the work was consolidated by putting the programme under the supervision of a general director, overall guidance on policy being provided by a joint administrative committee. Finally, in 1950, it was decided to expand the programme still further, and the Institute acquired its present form as a non-profit-making educational and research corporation under Federal charter with a board of directors and a full-time management. To stabilize the financial backing needed for the large-scale research programme, most of the companies in the industry entered into renewable five-year contracts with the Institute in 1953, providing annual support proportionate to their tonnage of production. At the same time the need for greatly enlarged headquarters became urgent; by 1955 plans for the new laboratories at Pointe Claire, near Montreal, had been drawn up, and the Government agreed to build and equip the new building to the Institute's specifications, the industry contributing part of the equipment. For the time being, the building on the McGill campus will continue to be used for post-graduate studies, some fundamental bench-type research, the main library, etc., but it is hoped that in due course these activities can be transferred to the new site, as funds and space become available.

The Institute has a full-time staff of 168, 131 of whom are technical and scientific personnel. Twenty-two graduates are at present participating in the thesis programme. The operating budget for 1958–59 is 1,500,000 dollars, one million dollars coming from Maintaining Member Company contributions, 100,000 dollars from a continuing annual grant of the Canadian Pulp and Paper Association and the remainder as revenues from sponsored research contract projects, chemical and physical testing and consulting services.

The research programme of the Institute covers a vast field, including the study of the chemical structure and properties of cellulose and polysaccharides, physico-chemical and chemical engineering investigations, for example, physico-chemical studies of paper-making fibres and flow and aggregating properties of suspensions, pulping and bleaching studies, disposal of waste liquor, paper formation, instrumentation and pulp and paper testing, analytical methods and the application of photography and microscopy in research. Thus, the Institute acts as a centre for fundamental research, supplementing the research organizations of individual companies. It stimulates and assists in the postgraduate training of students of McGill University, who are working for higher degrees in science and engineering, especially students whose theses deal with subjects of interest to the industry. Two hundred and fifty Ph.D. students have participated in this programme over the years, including a large number of students of chemistry and some chemical and mechanical engineers; it is hoped that in future students of physics, biophysics and biochemistry and biology will increasingly participate.

The Institute also conducts research at the request of individual companies, groups of companies and other sponsors in allied industries.

At the same time, the Institute acts as a clearing house and distribution centre for technical and scientific information, which is published in the form of monographs, bibliographies, translations, and critical reviews. Work carried out at the Institute is published in technical reports and articles in the periodical literature.

The different aspects of the work being done at the Institute were fully taken into account when planning the new building. Two-story blocks house the department of physics, physical measurement and electron microscopy; the mechanical engineering development sections with the adjacent chemical pulping pilot plant; the department for woodlands research, chemical pulping and fibre research, photography and microscopy and chemical analytical services, etc.; there are a refiner and stock-preparation building and a bleaching and small-scale pulping laboratory together with all the ancillary services such as woodworking, sheet metal and pipe-fitting shops, engineering offices, control laboratories, administrative offices with the branch library and a printing and duplicating shop. The buildings were designed to permit unrestricted expansion of any major section without interference with any other, this requirement being met by arranging the building in four wings each of which houses a particular type of operation. The design also permits working space to be redistributed both horizontally and vertically.

To work in buildings specially designed for the purpose will greatly assist the staff of the Institute in carrying out their investigations, and all workers in the industry can thus look forward to receiving an ever-increasing flow of valuable data and information.

S. LAMMLE

SCIENCE AND CIVILIZATION

IN his Sir Henry Simpson Newland Oration before the Australian Medical Congress at Hobart on March 5, now published in the *Australian Journal of Science* (**20**, 251; 1958), the Prime Minister of Australia, the Right Hon. R. G. Menzies, dealing with "Modern Science and Civilization", examined the place of science, including military science, in modern society. Great talent in science is not the monopoly of any one country, and Mr. Menzies, agreeing that the U.S.S.R. is training a greater proportion of its population in applied science than is any other country, pointed out that the Soviet Union could conscript young men and women into science at will and that there was reason to believe that Soviet technological man-power was excessively concentrated upon military production. The Soviet achievement with artificial Earth satellites should therefore be regarded with a sense of balance and not as a tragedy. Even if some ultimate military purpose lies behind the recent exercises, it simply means that the statesmen of the free world must seek both to maintain such a power of destruction in war as would deter aggression and also continue their efforts to persuade the Communist Powers that the immense possibilities of applied science should be increasingly diverted to the service of the peaceful needs of men and women.

A main theme of Mr. Menzies's address was to emphasize the need for a balanced judgment and to show how easily our own standards of civilization could be distorted. Scientists, he remarked, are not a race apart. They are citizens, bound to a social consciousness and social duties, and cannot, any more than non-scientists, stand apart from the great moral issues. The liberty of the scientist to pursue his chosen study is part of that great structure of self-governing and self-disciplined freedom which the institutions of the democratic world had painfully but persistently developed. That liberty is under challenge, and the scientist has a special interest and responsibility to share in its defence. Natural philosophy cannot make its best contribution to life unless accompanied by a moral and mental philosophy to give it balance. It would be calamitous for the specialist to contract out of the formulation and expression of a social consciousness which recognizes the paramount need to preserve the spirit and institutions of freedom.

After referring to some of the achievements in research of the free peoples, besides which those of the Communist world are insignificant, Mr. Menzies insisted on the need to take long views if civilization is to advance. It is a short answer to the Soviet achievements in the *Sputnik* field to suggest that we need only produce more and better scientists. The crucial question is for what purpose such scientists are to be used. We must recognize the danger of adopting Soviet methods to achieve Soviet results. Provision for scientific defence is for us solely a means of preserving democratic freedom and civilized individual rights. If such provision came to be regarded not as a free national effort but as something requiring the abandonment of freedom and acceptance of authoritarian control, we would have abandoned the case against Communism in the very effort to maintain that case.

Pointing out further that without more scientists and more scientific research the material future of the free world could not be assured and enlarged, Mr. Menzies also referred to the danger here of confusing ends with means. Whether scientific advance means human salvation or a new and complicated form of technological slavery depends on our character, our broad intelligence and our wise and understanding judgment. We must be ready to meet aggression with purpose as well as vigour, but our social policies and particularly our educational policies must be so devised as to encourage sanity and responsibility, and discover blundering accident. Psychologically, the true answer to the threat of war must be found in the improvement of the nature of man himself. The true end to be served is the enlargement of the human mind and spirit. We need more scientists, but also more scholars; more scholarly scientists; more scientific scholars; more historians and philosophers and poets. If science is truly to serve the cause of civilization it will be because the people who use the advances of science have grown to use them in a civilized way. Not all the most brilliant successes in laboratories and factories and fields would make a nation great in the eye of history if it had failed to enthrone the human spirit and to set about it knowledge, and justice, and patience, and understanding.

RADIO RESEARCH, 1957

WHILE research work devoted to various aspects of radio wave propagation is vital and should continue, it is recommended by the chairman of the Radio Research Board in his annual report* that the research programme of the Department of Scientific and Industrial Research Radio Research Station at Slough during the next five years should be broadened in scope, to ensure that experience is gained and progress made with other important topics. So far as possible, new fields of research should bear directly on practical applications, and examples include molecular amplifiers and oscillators, and the design and properties of microwave aerials. The radio transmissions from artificial Earth satellites, orbiting so that the source is sometimes within and sometimes above the ionosphere, already have provided a valuable new tool for examining ionospheric propagation, and frequency and directional measurements on the first two U.S.S.R. satellites were made at Slough. More accurate position data for the satellites are awaited before a full analysis of the results obtained is possible.

The work of the Radio Research Station is described in detail in the report of the Director, special emphasis having been given to items directly connected with the International Geophysical Year. In addition to the ionospheric observatories at Inverness, Port Stanley (Falkland Islands), Singapore and Slough, equipment designed or built at the Radio Research Station has been in operation at Halley Bay (Antarctica), Ibadan (Nigeria) and Port Lockroy (Grahamland). The Station has also been designated one of the four World Data Centres for the collection of all International Geophysical Year ionospheric data, the others being at Boulder (Colorado), Moscow and Tokyo. Data from about one hundred stations are sent directly to Slough, while those from some two hundred other stations arrive through the other three Centres.

Routine measurements over the current sunspot maximum period have yielded the highest monthly mean values of $F2$ critical frequency ever recorded over twenty-six years. This experience suggests that in considering the allocation of appropriate frequencies for short-distance radio communication, a frequency of 60 Mc./s. may be taken as the upper limit ever likely to be used in normal F-region propagation. Work has continued on the selection of a suitable ionospheric index of solar activity, primarily as an aid to forecasting propagation conditions. A preliminary investigation suggests that it might be possible to produce a permanent set of charts which would give the critical frequency at any point in the world for any phase of the sunspot cycle (defined in terms of the ionospheric index of solar activity), and which ultimately should render many of the current routine ionospheric measurements unnecessary.

Work on oblique-incidence radio propagation in the high-frequency and very high-frequency bands has continued. An investigation is being made into a possibility that commercial use may be made of the observed lateral deviations of the propagation direction from the great circle path for frequencies of the order of 20 Mc./s. when the latter mode has faded out. This phenomenon is not fully understood, but is thought to be due to some form of ground scattering. The value of the plan-position-indicator 'back-scatter' technique in the investigation of propagation modes to long distances is now established, and experiments are being made to compare the field-strength for forward propagation on a frequency of 17 Mc./s. with that for scatter reception from the same range. Another field of investigation is the forward-scattering of very high-frequency signals in the E-region, and associated with this form of propagation are the strong momentary enhancements of signal which are attributed to reflexions from sporadic meteors.

Long-distance 'scatter links' for ultra high frequencies, by which communication is obtained through forward scatter in the troposphere, are also being investigated at the Radio Research Station. Experiments are in progress on frequencies of 53, 1,370 and 3,500 Mc./s. used over different path-lengths, with the view of clarifying the problem of whether the propagation is maintained as a result of random fluctuations of refractive index caused by turbulence throughout the whole troposphere, or is due to variations of refractive index in relatively restricted layers of the troposphere. As an aid to this study, direct measurements of tropospheric refractive index have been initiated and have so far yielded encouraging results. Work has continued on the measurement of atmospheric radio noise, and equipment has been developed for routine use during the International Geophysical Year for measuring

* Department of Scientific and Industrial Research, Radio Research 1957: The Report of the Radio Research Board and the Report of the Director of Radio Research. Pp. iv+43+4 plates. (London: H.M. Stationery Office.) 3s. 6d. net.

the detailed features of the noise in the frequency-range 15 kc./s.–30 Mc./s. with the view of elucidating the mechanism whereby individual lightning flashes give rise to noise at different frequencies.

Observations of the phase and amplitude characteristics of very low-frequency waves (10–20 kc./s.) reflected from the ionosphere are also described in "Radio Research 1957". The experimental work, which bears directly on the application of such waves for navigational aids over long distances, is being supplemented by theoretical work on the propagation of very low-frequency waves.

In addition to the work on radio propagation over a wide frequency-range, the Department is engaged on the development of radio-frequency power measuring standards, and research into semi-conductors and magnetic and dielectric materials. Work on germanium has been superseded by that on silicon filaments and commercial transistors, with particular reference to performance at very high radio-frequencies. The magnetic properties of a wide range of ferrites and other metal oxides and their applications to microwave measurements are being investigated.

Some of the work described in the report is undertaken, under contract with the Department, at various universities. A list of papers published during 1957 is given as an appendix. GEOFFREY M. BROWN

ECOLOGY OF SOIL FUNGI

THE growth, activities and interrelationships of fungi in soil provided the basis for a symposium on "The Ecology of Soil Fungi" held at the University of Liverpool during August 19–21. The meeting, attended by ninety scientists from thirteen countries, was divided into six sessions, which were presided over, respectively, by Prof. N. A. Burges (University of Liverpool), Dr. P. W. Brian (Imperial Chemical Industries, Welwyn), Dr. J. Harley (University of Oxford), Prof. J. Guillemat (École National d'Agronomique, Grignon), Prof. J. Ziemiecka (Institut Uprawy, Pulawy, Poland) and Dr. H. Katznelson (Canadian Department of Agriculture, Ottawa). Each session included a review of one aspect of the subject and four or five shorter papers: most of the twenty-eight papers presented were circulated before the symposium and this undoubtedly contributed greatly to the very lively discussions.

Review papers by Dr. J. H. Warcup (Waite Agricultural Institute, Adelaide, read by Dr. Parkinson and J. S. Waid (Fisons, Levington) dealt, respectively, with the isolation and estimation of activity of fungi in soil and the effect of environmental conditions on fungal growth in soil. Synecological investigations which were afterwards discussed included: the fungi associated with pine litter and couch grass debris (Dr. D. Parkinson and B. Kendrick, University of Liverpool); the distribution of Chytrids in lake muds and soil (Dr. L. G. Willoughby, Fresh Water Biological Association, Ambleside); the microflora of sandy soils in the Sahara (Dr. J. Nicot, Natural History Museum, Paris); the fungal flora of tidal mud flats before and during colonization by *Salicornia stricta* (Dr. G. J. F. Pugh, University of Nottingham); the growth of fungi in forest and grassland soils (Dr. R. H. Thornton, Soil Bureau, Wellington, New Zealand, read by Dr. Parkinson); and the rhizosphere flora of *Abies* of different ages (Dr. R. Moreau, École Nationale de Médecine et de Pharmacie, Besançon). During the course of these papers and the discussions, the need for a greater knowledge of the origin of fungal isolates was emphasized. The use of the soil dilution plate count method, a subject of some considerable debate, was ably defended by Prof. J. Montegut (École National de Horticulture, Versailles), and an account of the use of this method in studies of the effects of nitrogen, phosphorus and potassium on soil fungi was submitted by Profs. J. Guillemat and J. Montegut. Dr. E. H. Garrard (Ontario Agricultural College) surveyed the detailed work on *Streptomyces scabies* at Guelph. Direct-observation studies of *Verticillium albo-atrum* in soil and tomato roots were described by Dr. G. W. F. Sewell (East Malling Research Station), and Dr. H. Tribe (University of Cambridge; read by Dr. S. Hepple, National Institute of Agricultural Botany, Cambridge) discussed his observational work on the decomposition of buried cellulose film.

A review by Dr. Brian of the antagonistic and competitive mechanisms limiting survival and activity of fungi in soil was followed by an account of antagonism as the background in which fungi live (Dr. D. Park, University of Manchester), and a description by Dr. R. Barton (University of Manchester) of investigations of substrate colonization by *Pythium mamillatum* under different conditions. Drs. A. G. Winter, F. Schonbeck and H. Peuss (Botanische Abteilung Madans, Köln Merhiem) discussed biotic factors, with reference to 'hyphospheres' and mycorrhizæ, affecting the development of soil fungi. Soil fungistasis, which Dr. Brian also included in his survey, was the subject of a paper by Dr. C. G. Dobbs, who reviewed some methods of study developed at the University College of North Wales, Bangor. Drs. Dobbs and J. Bywater (Bangor) described a seasonal variation in fungistasis in certain soils, and Dr. R. M. Jackson (Rothamsted Experimental Station) discussed the effect of living roots on the germination of fungal spores in soil.

Prof. Burges, in his paper "Dynamic Equilibrium of Soil Populations", discussed the effects on the soil micropopulation of seasonal fluctuation in depositions of organic matter. The uses of radiocarbon in studies on cellulose and lignin breakdown were described by Dr. J. Mayandon and Prof. P. Simonart (University of Louvain), while problems associated with the isolation of humic acid and its utilization as a nutrient by fungi were the subjects of a paper by Prof. Burges and Miss P. M. Latter. Certain aspects of fungal physiology in relation to soil studies were reviewed by Dr. Harley, whose paper was followed by accounts of the use of physiological methods, relating to oxidative metabolism, in mycological studies (Dr. D. Boulter and H. M. Hurst, University of Liverpool) and a demonstration by Dr. M. E. K. Henderson (Macaulay Institute, Aberdeen) that a number of fungi are able to decompose molecules related to lignin. Prof. C. G. C. Chesters (University of Nottingham) reviewed prob-

lems associated with the decomposition of organic matter in soils and stressed that all the different organisms concerned should be considered.

Dr. Katznelson, in an evening lecture, surveyed the work of the Bacteriology Division of the Canadian Department of Agriculture on rhizosphere problems. The ecological events in the rhizosphere and the general health of the plant were discussed in the light of the results of these studies.

Demonstrations, which were available for inspection throughout the period of the symposium, included an exhibition of the use of tracer techniques with special reference to studies of fungal growth in soil (Dr. E. Grossbard, Grassland Research Station, Hurley), the screened immersion plate technique (Dr. Thornton), and examples of soil sections prepared by a resin impregnation method (Dr. S. Hepple and Prof. Burges). The other exhibits were concerned with mycorrhizal studies. Slides and figures illustrating internal and external mycelial phases of vesicular-arbuscular endophytes associated with grass roots were presented by Dr. T. H. Nicolson (University of Nottingham), and Dr. B. Mosse (East Malling Research Station) demonstrated a method of obtaining pure inocula of an *Endogone* sp. capable of causing vesicular-arbuscular mycorrhizal infections: typical infections produced in apple, strawberry and onion roots were shown. Dr. D. G. Downie (University of Aberdeen) demonstrated strains of *Rhizoctonia solani*, pathogenic to potato, wheat and cauliflower, which stimulated embryo development of *Orchis purpurella*, and Dr. I. Levisohn (Bedford College, London) showed the growth of mycorrhizal mycelia on sterilized litter.

It is a pleasure to record the generous hospitality of the University of Liverpool and the excellent organization of this most informative and enjoyable meeting. The organizers are preparing the full proceedings of the symposium for publication by the University of Liverpool Press.

G. J. F. Pugh
G. W. F. Sewell

PHYSICS OF ICE MOVEMENT

A SYMPOSIUM on the "Physics of Ice Movement" was held at Chamonix during September 16–24. It was organized by the International Association of Scientific Hydrology for its daughter Commission for Snow and Ice, and was attended by some eighty-five glaciologists from fifteen countries. The work of the symposium was greatly facilitated by the feat of the secretary of the Association, Prof. L. J. Tison, in publishing the forty-one papers submitted for the symposium in time for the opening session*. The president of the Commission, Prof. R. Finsterwalder (Munich), presided over the symposium, and Prof. A. Bauer, one of the vice-presidents, organized the details; despite poor weather, he managed to arrange two whole-day excursions of great glaciological interest as well as twelve working sessions. It is, of course, impossible to summarize all the papers here, and I will only try to give some impression of the material presented in the wide range of relevant subjects discussed, which ranged from the deformation of single crystals of ice to the behaviour of the Antarctic ice sheet.

Prof. U. Nakaya (Sapporo, Japan) reported the results of some very beautiful tests performed on single crystals of ice of great perfection derived from an Alaskan glacier. Rectangular bars cut from these crystals in various orientations had been deformed by bending, and the resulting deformation studied by shadow photography, which reveals the glide planes, and by polarized light, to determine changes in crystal orientation. All the phenomena of gliding and low-angle boundaries observed in hexagonal metals are to be seen, and the geometry of the deformation, deduced by Nakaya, was shown by Dr. J. F. Nye (Bristol) in the symposium to have a close relation to the theory of deformation by continuous distributions of dislocations. The flow law for ice single crystals was discussed by Dr. T. R. Butkovich and Dr. J. K. Landauer (Snow, Ice and Permafrost Research Establishment, United States), who found that for single crystals, like polycrystalline aggregates, the relation between minimum strain-rate and stress can be well represented by a power law for stresses around 1 bar. They used shear tests, and found that if the crystal is oriented for easy glide on the basal plane, the flow is considerably faster than for polycrystals, whereas if the specimen is oriented so that no glide on the basal plane is possible under the applied stress, then the minimum strain-rate is of the same magnitude as that of polycrystals. Butkovich and Landauer also reported results of tests on polycrystalline ice, and further tests of this kind were reported by Prof. S. S. Vyalov (U.S.S.R.) and by Dr. S. Steinemann (Neuchâtel, Switzerland). They all confirmed that a power law represents the data well over a range of strain-rates from 10^{-9} to 10^{-5} sec.$^{-1}$, but at the limits of this range there are signs that the law ceases to hold, in the sense that the power decreases for the low strain-rates and increases for the high ones. Steinemann also found that he could plot a similar power law for the final strain-rate to which the specimen settles down (as opposed to the minimum rate). In this state the ice is recrystallizing during the creep, and it is of particular interest that he has results for both compression and shear tests so that the relations usually assumed to hold between the results of these two types of stressing system can be tested. He finds that the relations are not obeyed, and that the disagreement is particularly bad in the case of the final rate—a result which is perhaps not so surprising when it is realized that the recrystallization is producing quite different textures in the two cases. Since, however, it is this final rate which is probably most relevant to the rate of flow observed in glaciers, this may well mean that glacier theories made with the usual assumptions are subject to some error. Dr. J. W. Glen (Birmingham) in his paper discussed what possibilities there might be for a flow law without making the assumptions in question.

Experiments on glaciers which have bearing on the mechanical properties of ice were reported by several authors. Dr. B. L. Hansen and Dr. Landauer (Snow,

* Union Géodésique et Géophysique Internationale, Association Internationale d'Hydrologie Scientifique, Symposium de Chamonix 16–24 Sept., 1958. (Gentbrugge: Association Internationale d'Hydrologie Scientifique (61 rue des Ronces), 1958.) Pp. 394. 300 frs. belges.

Ice and Permafrost Research Establishment) used measurements of the rate of closure of a hole drilled 1,346 ft. into the Greenland ice sheet to deduce the flow law of the ice, and found results in good agreement with the laboratory work, and Dr. C. C. Langway of the same laboratory reported measurements on the pressure of bubbles in the cores removed from this drill hole which showed that the bubble pressures largely reflected the weight of the overlying ice. However, if the specimens were kept for one year before testing, the bubble pressure never exceeded a certain value, showing that bubbles of greater pressure than that, although they had survived intact the process of being brought to the surface in a core, had relaxed their pressure during the year, and microscopic examination showed small cracks spreading from these bubbles. A further series of mechanical tests on ice were reported by Prof. Nakaya, who has measured the resonant frequency and the damping of bars of ice from various sources as a function of temperature. Recent results which he reported in the symposium, but which are not in his submitted paper, show that the peaks in a plot of damping versus temperature depend critically on the ice used, peaks being present in glacier ice which are not present in single crystals, and laboratory ice being different again. Nakaya's interpretation of this in terms of such things as the mechanical properties of grain boundaries was challenged by Steinemann in the symposium, who suggested that perhaps proton movements associated with the boundaries might be responsible—thus emphasizing that ice, though in many ways similar to a metal, has its differences.

Steinemann also discussed the recrystallization structures of ice, as did Prof. P. A. Shumskiy (Moscow) and Dr. G. P. Rigsby (San Diego). Steinemann used the results of his laboratory tests to discuss the recrystallization and intragranular movements that occur in glaciers, Shumskiy distinguished six mechanisms of straining and their corresponding structures according to the magnitude and type of stressing, and Rigsby presented the results of observations of the preferred orientations found in glaciers and after laboratory tests. In a second paper, Steinemann discussed the applicability of laboratory tests made on ice at temperatures below the melting point to the discussion of the behaviour of temperate glaciers, which are at their melting point and therefore contain some liquid water. He has analysed the stability of the liquid phase theoretically, and concludes that water droplets will only be stable at the intersection between four grains. Thus, until a certain quite high percentage of the ice has melted, the temperate glacier will consist of essentially 'dry' ice with water droplets at four-grain intersections. These droplets will raise the effective stress on the rest of the ice somewhat, but not by a factor out of proportion to the fraction melted. As a result, Steinemann concludes that results of tests on cold ice can be applied to temperate glaciers without serious error.

Naturally, several of the papers were devoted to aspects of the theory of glacier flow. One of the main topics discussed here was the propagation of surges through glaciers. If a glacier develops a greater thickness in some part, as a result, for example, of a very snowy winter, a wave of increased thickness will travel down the glacier at a velocity greater than the velocity of flow itself. A paper on the theory of this phenomenon was published earlier this year in *Nature*[1], and at the symposium, Prof. L. Lliboutry (Grenoble) analysed the observations made on the Mer de Glace during 1891–95 by Joseph Vallot to test this theory. He showed that, although there was qualitative agreement in that a wave of increased thickness moved through the glacier several times faster than the flow velocity, the agreement was not quantitative, and he suggested various possibilities to account for this. His main suggestion was that the friction on the bed may not be completely accounted for on the current theories, but that at high speeds it may diminish considerably due to the inability of the ice to close up behind obstacles past which it has flowed. Dr. J. Weertman (Washington, D.C.) also presented a paper on the subject of surges in which he developed further the theory of their propagation, and in particular discussed the question of the change in shape of the surface of such a surge.

Another sort of wave on a glacier was discussed by Dr. Nye; the waves in question are the undulations which form beneath ice falls and which have a wave-length corresponding approximately to the flow in one year; they are often called wave ogives, and sometimes pressure arches, since pressure was assumed to be responsible for their formation. Dr. Nye has pointed out that in an ice fall where a high velocity is reached, accompanied by an extension of the ice, such waves are to be expected from the fact that glacier flow continues throughout the year, whereas the ablation (loss of ice from the glacier surface) occurs only in summer. Using a simple theory in which it is assumed that the velocity is constant throughout the year and that the ablation occurs suddenly once a year, he showed how such waves could be predicted from velocity and ablation data. He then applied this theory to the ice fall on Austerdalsbreen (a Norwegian glacier), for which measurements of these quantities are available, and found that the location of the crests and troughs agrees well with the predictions, and the order of their amplitude is right, though they are, in fact, less marked than the theory predicts—a result that is to be expected if the assumptions made in the theory are relaxed in a reasonable way.

Among others who discussed glacier theory, Prof. M. Matchinski (France) emphasized the importance of obtaining glacier theories which could be used to describe any glacier of complex shape, and proposed a theory to do this containing parameters to be determined from the glacier itself, and Prof. D. Tonini (Italy) suggested the use of the concept of the characteristic time of a glacier to describe the rate with which the outflow of material on a glacier responds to a change in its accumulation.

Measurements of ice movement on glaciers were naturally also discussed, and here one of the most interesting contributions came from Prof. R. G. Millecamps and M. M. Lafargue (Paris). They have sunk a large number of barium titanate ultrasonic transmitter/receiver units into the ice at the corners of a rectangular lattice, and have used measurements of the time taken for signals to travel between the different units for determining the strain suffered by the ice. At present, only preliminary results are available, and these seem to be curiously irregular; however, the technique is clearly one that holds out great promise, since it enables the full deformation of the ice through the depth of the glacier to be measured. A second technique of great importance was reported by Profs. R. P. Sharp and S. Epstein (California Institute of Technology). They have used the variations in the ratio of the isotopes oxygen-18 and

oxygen-16 to determine the history of different parcels of ice. This ratio varies according to the season of the year, and also the altitude of the place in which the snow fell, and they quoted several examples where it had been of value in confirming whether ice samples found to be close to each other in the lower reaches of a glacier in fact came from the same region.

One of the most interesting developments in more orthodox methods of glacier study is the increasing use of photogrammetry, both terrestrial and aerial, to determine not only the map of a glacier, but also the velocity of flow and the variation in surface height of glaciers. For flow measurements, the photographs are usually taken with an interval of several days, and preferably from an identical position, but it was shown that even aerial photographs (which are necessarily not taken from exactly the same position on two different flights) could be used, if necessary, to determine glacier flow. There was some discussion of the best method of analysing such photographs, M. M. Baussart (Paris) favouring the plotting of two maps, one for each date, and deducing the velocity either from these or from the data from which they are constructed, whereas Dr. W. Hofmann (Munich) preferred to use two photographs taken at different times to give the velocity directly. However, it seems clear that both techniques give accurate results, and can even do so when no ground control at all is available. There were also many reports of measurements of glacier flow and variations of the more conventional kind, and perhaps the most interesting of these were some of the first results of International Geophysical Year expeditions to Antarctica given by Dr. L. D. Dolgushin (Moscow) and Dr. J. H. Zumberge (Ann Arbor, Michigan). The former described the features developed by flow in the large outflow glaciers of Queen Mary Land, while the latter reported on the deformation features on the Ross Ice Shelf.

J. W. Glen

[1] Nye, J. F., *Nature*, **181**, 1450 (1958).

THE HUMAN OPERATOR AND HIGH-SPEED FLIGHT

THE first International Congress of Aeronautical Sciences was held in Madrid, during September 8–13, when representatives from twenty countries met to discuss forty-five papers delivered under the presidency of Dr. Theodore von Kármán.

The subjects included theoretical and applied science dealing with structures, aerodynamics, speed, height, range, propulsion, the handling of supersonic aircraft, navigation, aircraft taking-off and landing vertically, engine noise, and also the important subject of human engineering.

The human element is the limiting factor which faces the designer and operator of the new generation of high-speed aircraft. But considerable information has been accumulated over the past fifteen years about the physical and mental strains on a pilot subjected to violent manœuvres, and also about the psychological factors causing fatigue and thus an involuntary falling-off in efficiency. This experience has come from branches of science outside the general field of aeronautical engineering, namely, in the aero-medical field including physiology, neurophysiology and psychology.

From the early stages of design study for a new aeroplane the problem of the human operator is studied by scientists working with the design team to ensure that human limitations do not prevent the machine being flown to the best advantage.

Military and civil aircraft present some common problems, but naturally those of the combat aeroplane are particularly difficult; pioneering work on military aircraft is frequently useful for the later generations of civil machines, including the now familiar pressure suits worn by air-crews for the protection of the body against physical damage, and radar devices for navigation.

An invariable problem posed by the human operator and his working space in the cockpit lies in variations in size and shape of body, and arm- and leg-reach, all in some way affecting operating comfort and efficiency and involving, for example, the clearance between apparatus, controls, and the canopy. More intangible problems are those concerned with muscle, nerve and brain, underlying the senses and reactions, and much has yet to be discovered.

Laboratories exist in many countries for practical work as well as for theoretical analyses in the study of human engineering, which applies to any task in which physical and mental co-ordination is required of the operator. Too many tasks in the past have been carried out by the human operator adapting himself to the machine, whether it be aeroplane, machine tool, forging machine, or instrument observation.

The aircraft designer is thus increasingly required to range over a varied scientific field, and to consult other specialists on the human operator aspect. The following topics were discussed at the Congress:

(1) Simplification of the work of the air-crew, both physical and mental.

(2) The study of all aspects of visual observation both inside and outside the cockpit, including the design and arrangement of the instruments. Outside the cockpit the angle of view from a pressurized aircraft is limited, and with increase in performance a television display, reliable under all weather conditions, is desirable.

(3) Location, design and shape of controls, levers, and knobs, for instant recognition by sight or touch, day or night.

(4) Reliable information about what fuel remains at any given time, and what aerodromes are available within the remaining range.

(5) Warning lights that are insistent, but not too violent, for vital emergencies, and illuminated descriptive panels for secondary troubles.

(6) Air conditioning and temperature control.

(7) Methods of escape to safety in case of an emergency; the self-contained detachable cockpit dropping by a parachute, after clearing the air wreck, to a suitable altitude from which the crew can escape on their own parachutes.

(8) Disorientation in flight.

(9) Protection against cosmic radiation during space flight.

(10) The problem of weightlessness in space.

Observing, thinking and making a movement takes time whether it concerns operating an aeroplane, a machine tool or playing the piano, but smooth and apparently effortless action by an operator having a mastery of his task shows a high degree of combined skill.

The hazards and increasing complication of flying have encouraged great efforts to be made to reduce the reaction-time of air-crew, between hearing or seeing some signal and acting on it. One action may have to be followed by a second or a third, all taking time depending on how much mental interpretation is required after observing the dials and lights. A good deal of work can be performed quickly by robot-type apparatus; but it can carry out only what it has been programmed to do, and cannot readily be adapted to differentiate between courses and evaluate alternative action. Robot apparatus, moreover, frequently occupies much space and is weighty, and it needs skilled attention to keep it serviceable.

Extending the pilot's senses without increase in fatigue is an important factor in getting the best out of an aeroplane. Vision is most important: many miles will have been travelled in the few seconds required to stop observing an instrument a few feet away on the cockpit panel, and to sight and recognize a distant aeroplane.

Quick-acting robot apparatus is best used in relieving the pilot of physical tasks; for presenting the assorted instrument readings as integrated results; and for displaying a flat television picture of the view around the aeroplane.

While aircraft design and construction has to conform to accepted standards and official specifications, no such definite direction is possible on the more intangible aspects relating to the human operator and so every new experience reported by air-crews is carefully studied, and may be the starting-point for further aero-medical research.

The many instruments on cockpit panels are arranged in groups or in horizontal and vertical rows so that the readings relating to a particular operational function may be viewed together. This helps in the rapid assimilation of facts from which the pilot mentally assesses the conditions. There remain the possible chance of error in observation, and the time-lag before any action follows: to improve matters, apparatus is being developed which will receive the instrumental readings and give the pilot a combined result from which he can take immediate action.

Thus the process of adapting the aeroplane to the pilot continues and reduces the chances of accidents due to so-called 'pilot error'. It has been a convention to attribute many crashes to "an error in judgment on the part of the pilot" when, in fact, the cause has been due to confusing or difficult operating conditions, which become more hazardous when the pilot is fatigued and flying conditions are bad.

The experience of the past ten years is now being used in the design study of new manned aircraft, and tasks apparently impossible for the pilot are now being assigned to apparatus with the pilot as the master mind. For example, an apparatus designed to relieve the pilot during combat at high speeds is the Ferranti 'Airpass' system (airborne interception radar and pilot's attack sight system). After several years development it is now fitted in the English Electric *P.* 1*B* high-speed fighter. 'Airpass' starts to operate when the fighter is beamed in the direction of a target, it scans ahead and when the target is located the radar locks on and a computer finds the best course for the aeroplane. The pilot observes the essential facts in his sights and acts at the right time. He has been relieved of the visual strain and the anxiety of determining the correct course and can concentrate on the proper time to fire.

Progress has been helped greatly by the aero-medical pilots who understand test flying and take part in it, co-operating with other specialist scientists in the design team in the study of the operational requirements of a new aircraft, and how these can best be met. A full-scale cockpit model is tested under varying climatic conditions for maximum operational periods. These tests disclose discomforts due to pressure suits, difficulties in making movements to operate controls and switches, and escape facilities. In adapting the future aircraft to the pilot it must be emphasized that operation at supersonic speeds presents conditions of control quite different from those in sub-sonic flight, while kinetic heating demands a cooling system to prevent excessive rises in temperature.

Present-day control columns and rudder pedals will probably give way to a set of small hand levers on the pilot's desk console, which will also have communication aids and signals, the television picture of the outside view being at eye-level beyond the console, and visible to any other members of the air-crew.

The new self-contained type of control cabin can more readily be accommodated within the best aerodynamic shape, avoiding the usual sharp hump in the top curve of the fuselage due to the cabin windscreen and roof. The windscreen spoils good performance at supersonic speeds, and it should not be permitted in the new aircraft using television display. Operation would be entirely by remote control using television and other instruments, but a retractable periscope would be useful for ground manœuvring.

Other fields of human engineering include the operation of cars and lorries, fast Diesel trains, automatic manufacturing plant, and many others co-ordinated by the Ergonomics Research Society and covering international interests.

It would not be realistic to suppose that manned combat aircraft will become obsolete in the near future, and it may be assumed that air-crew will be needed for many military operations, but their task must be made simpler. Unmanned robot aircraft and missiles have a future. But it is unwise to think that these could replace certain attack and defence duties.

The important development of VTOL aircraft (vertical take-off and landing) and STOL aircraft (short take-off and landing) were discussed at the Congress, and it was emphasized that failure-proof apparatus for autostabilization and landing are essential if these types of aircraft are to be successful.

Human engineering applied to helicopters is concerned with control factors quite different from those of the fixed-wing aircraft, but some basic problems are similar. When controlling a helicopter, the pilot is continually using his hands and feet to maintain stability, and at present it is necessary to keep the ground in view, until a reliable automatic-pilot system is available to permit safe flying in all weathers.

The special senses reacting to linear and angular movement often prove misleading to a pilot when he is not engaged in steady straight flight, yet these are two of the three main sources of information about orientation which emphasizes the supreme importance of the eyes. Under some conditions of prolonged

manœuvre even the eyes may prove misleading for a time during the manœuvre, or immediately after it has been completed. Facts on the limits of human tolerance in aviation and on the question of reaction-times are being accumulated in the leading national institutions, so that more data are available to designers.

Crew for manned space-flights will have to be selected from test pilots trained to retain normal physiological and psychological functions under severe conditions.

Two problems which are particularly difficult to study on the Earth are those of weightlessness, and the effects of cosmic radiation. Weightlessness, which can be studied for short periods under certain conditions of parabolic flight, causes disturbances of muscular co-ordination and the nervous system, leading to awkward functions of certain reflexes. There may also be long-term effects on respiration and disturbance of the alimentary canal. Generally, there is likely to be a reduction of the input of information to the sensory pathways of the brain, and thus some effect on the mental processes. Recent data from *Explorer* satellites and the *Sputnik* 3 reveal a belt of intense radiation between latitude 30° N. and 30° S., at a height of about 6,000 miles and beyond. This may be a serious barrier to manned rockets in this region, but in the equatorial zone there seems to be relatively little radiation, according to the information at present available, so that it may be possible for future manned rockets to avoid this hazard to some extent.

A. Cadman Clinton

HYDROMEDUSAE NEW TO THE BRITISH LIST FROM THE FIRTH OF CLYDE

By C. EDWARDS

Marine Station, Millport, Scotland

In the course of work on the plankton of the Firth of Clyde a survey of the Hydromedusae has been made from early 1956 to the present date, because of their value as hydrographic and biological 'indicators'[1,2] of conditions in the area. Further, it is thought that they are a valuable guide to the zoogeographical relationships of the Clyde fauna. Finally, this survey may prove of service in the future in the detection of any long-term changes in the fauna.

The Clyde fauna has proved to be rich in number of species of Hydromedusae, forty-seven species having been found during this work. A full report on them will be published on completion of the survey. As, however, the four undermentioned species, new to the British list, have been found, this preliminary note is of value at the present stage.

Plotocnide borealis Wagner. Twelve specimens have been taken in surface tow-nettings at Millport in April and May 1956 and during February-April 1957. None has been found in 1958. Routine daily surface-water temperatures on the dates of capture ranged from 6·1° to 9·0° C. The earlier occurrence of the species in 1957, compared with 1956, reflected the much milder winter and earlier spring of 1957 compared with the previous year. Its apparent absence in 1958 may have been due to the fact that cold winter conditions were unusually prolonged and were followed by an exceptional period of persistent east winds, which delayed the onset of spring conditions and appeared to disfavour certain forms normally occurring in late winter and early spring.

This species has been considered to be an arctic one of circumpolar distribution[3,4], having been reported from western Greenland, the White, Barents and Chuckchee Seas and the Sea of Okhotsk. However, Beyer[5] recorded its occurrence in the Oslofjord between 1946 and 1953, although he suggested the possibility that it may there be an arctic survivor from some cold period, capable of living at the temperature (about 6° C.) of the deeper layers of the Oslofjord.

The survival of *Plotocnide borealis* in the Clyde area as an arctic relict is extremely unlikely. While its accidental introduction into the area in the hydroid stage is possible, it is considered unnecessary to attribute its presence here to that cause. It is a very small medusa, easily overlooked and nowhere reported as abundant, and its apparently disjunct distribution may be due to limitations of collecting. Its occurrence in the Clyde area over at least two years suggests that conditions here are suited to the species. The medusa faunas of the regions from which *Plotocnide borealis* has been reported include a number of other species the ranges of which extend from arctic to boreal regions, such as *Hybocodon prolifer*, *Rathkea octopunctata*, *Staurophora mertensi*, *Tiaropsis multicirrata* and *Aglantha digitale*, all of which occur in the Clyde area. The presence of northern boreal and boreal-arctic forms in arctic seas is well known. For example, Gurjanova[6] has shown, in the case of amphipods, that many Atlantic northern boreal species have penetrated into the deeper parts of the Russian arctic seas because of relatively warm water in the deeper layers of the Arctic basin. It is significant that Jaschnov[4] reports that, in the Barents Sea, *Plotocnide borealis* occurs in the deep layers. The appearance of many boreal species in the waters off western Greenland during recent decades, because of climatic change, is well known[7]. The presence of deep, cool water in the Firth of Clyde may favour the establishment of any cold-water forms entering the area. It is considered that *Plotocnide borealis* can no longer be regarded as a purely arctic species, but its true distribution must await further discovery. The hydroid stage is unknown.

Bougainvillia muscoides (M. Sars) [*B. nordgaardi* (Browne)]. This medusa has hitherto been reported only from fjords on the west coast of Norway between Bergen and Molde, a single offshore locality north-east of the Shetlands, and one station over the Wyville Thomson Ridge[8]. In addition, the hydroid has been recorded from the west coasts of Sweden and Norway[9]. In Norway the medusae have usually been found from August to November, and exceptionally in April and May.

The species occurred at Millport in 1956, twenty-one specimens being found between September 18 and October 11. The fact that various stages were taken, ranging from very young ones to adults, indicated that the hydroid was present in the area. This species exemplifies faunal similarities between the west coasts of Scotland and Norway. It is probably present elsewhere along the Scottish west coast, as is suggested by the record from over the Wyville Thomson Ridge.

Bougainvillia macloviana Lesson. This well-known species is widely distributed and abundant in antarctic and subantarctic waters[10]. It has, however, been repeatedly found since 1895, though in limited numbers, in the southeastern part of the North Sea at Heligoland and off the East Frisian Islands, during April, May and June[11,12]. Its occurrence in the North Sea is attributed to transportation of the hydroid on ships from the antarctic.

One adult medusa was taken in the Firth of Clyde on June 14, 1956, and the introduction of the species into this area is similarly explained as due to transportation from the southern hemisphere. Whaling vessels from the Antarctic frequently lie up in the lochs off the Firth.

Tiaranna rotunda (Quoy and Gaimard). This species is recorded from the Straits of Gibraltar and the region immediately to the east, the northern North Sea, fjords in western Norway, the Skagerrak, Davis Strait, the Irminger Sea (between south-west Iceland and south-east Greenland), and the South Atlantic and Antarctic Oceans[3,10,13]. It is a deep-water species only occasionally ascending towards the surface. Russell, in his account of the British medusae[14], included it on the ground that, although not recorded from the British area, it might occur over deep water off our western and northern coasts.

Twelve specimens have been taken off Great Cumbrae Island, Firth of Clyde, two during October and November 1956 and the remainder between July and December 1957. Three were adult, the others very small. The species was evidently resident in the area. With the exception of one adult specimen taken in an oblique haul from 90 metres depth to the surface, all the others were caught in surface townettings. The presence of a considerable body of fairly deep water (attaining 168 m. or more in depth) in the Clyde area has enabled the species to establish itself here.

Of additional interest is the discovery that the young stages, previously unknown, agree very closely with the description and figures of *Modeeria formosa* Forbes[15], based on a single specimen taken off Mull in the autumn of 1845 and not recorded since. It is highly probable that the two species are identical, but, because of the uncertainty of Forbes's specimen, it is advisable not to disturb the well-established name of the species. Descriptions of the young stages will be published in due course.

[1] Kramp, P. L., *K. danske vidensk. Selsk.*, naturv. math. Afd., 8 Raekke, **12** (1), 225 (1927).
[2] Russell, F. S., *J. Cons. int. Explor. Mer*, **14**, 171 (1939).
[3] Kramp, P. L., *Medd. Gronland*, **81** (1), 22 (1942).
[4] Jaschnov, W. A., *Bull. Soc. Nat. Moscou*, Sec. Biol., N.S., **48**, 108 (1939).
[5] Beyer, F., *Nytt. Mag. Zool.*, **3**, 94 (1955).
[6] Gurjanova, E. F., *Tabl. anal. Fauna U.R.S.S.*, **41**, 69 (1951).
[7] Jensen, A. S., *Biol. Medd. Kbh.*, **14** (8), 1–76 (1939).
[8] Kramp, P. L., *Dan. Ingolf-Exped.*, **5** (10), 43 (1926).
[9] Jäderholm, E., *K. svenska Vetensk Akad. Handl.*, **45** (1), 46 (1909).
[10] Kramp, P. L., *Discovery Rep.*, **29**, 9 (1957).
[11] Hartlaub, C., *Nord. Plankt.*, **12**, 156 (1911); **12**, 406 (1917).
[12] Künne, C., *Zool. Anz.*, **101**, 249 (1933).
[13] Kramp, P. L., *Dan. Ingolf-Exped.*, **5** (14), 50 (1947).
[14] Russell, F. S., "The Medusae of the British Isles" (Cambridge University Press, 1953).
[15] Forbes, E., "The British Naked-Eye Medusae" (Ray Soc., London, 1848).

NUCLEOTIDE POOL OF BREWERS' YEAST DURING GROWTH AND FERMENTATION

By G. HARRIS, J. W. DAVIES and R. PARSONS

Brewing Industry Research Foundation, Lyttel Hall, Nutfield, Surrey

IT is known[1,2] that yeasts contain pools of nucleotides analogous to the reserves of amino-acids[3]. A detailed analysis of the nucleotide pool of bakers' yeast at one stage of growth, made[1] by extracting the organism with cold perchloric acid followed by chromatography of the acid-free extract on 'Dowex'-1 (formate), showed that it contained the mono-, di- and tri-phosphates of adenine, guanine, cytosine and uracil together with various new nucleotides, notably uridine diphosphate glucose (UDPG) and uridine diphosphate acetylglucosamine (UDAAG)[4]. We have now examined the nucleotides present in a brewers' yeast (*Saccharomyces cerevisiae*, National Collection of Yeast Cultures, No. 240) at successive stages of growth and fermentation.

The yeast was grown aerobically for 48 hr. and inoculated into brewers' wort, when it was allowed to grow and ferment without agitation. The methods employed for analysing the cells differed from those used by earlier workers in that extraction was performed in two stages, the first using hot aqueous ethanol for a limited period and the second cold trichloracetic acid. The two extracts from each sample of yeast were individually chromatographed on 'Dowex-1' (chloride), following Pontis and Blumson[5], to give the chromatograms shown in Figs. 1 and 2.

Clearly, the total nucleotides are divided by these means into two main groups. The first contained the compounds previously observed in bakers' yeast together with at least five unidentified nucleotides (1–5), while the second group comprised a large number of new components (7–31, Fig. 2). Full details of the properties of the unidentified materials will be published elsewhere. Figs. 1 and 2 reveal, moreover, remarkable changes in the nucleotide pool as the development of the yeast proceeds. In particular, the nucleotides extracted by trichloracetic acid show a considerable increase both in amount and diversification during the first four hours, that is to say, in that period in which the yeast is preparing to undergo its first division. So far as can be judged from the number of samples examined, this increase

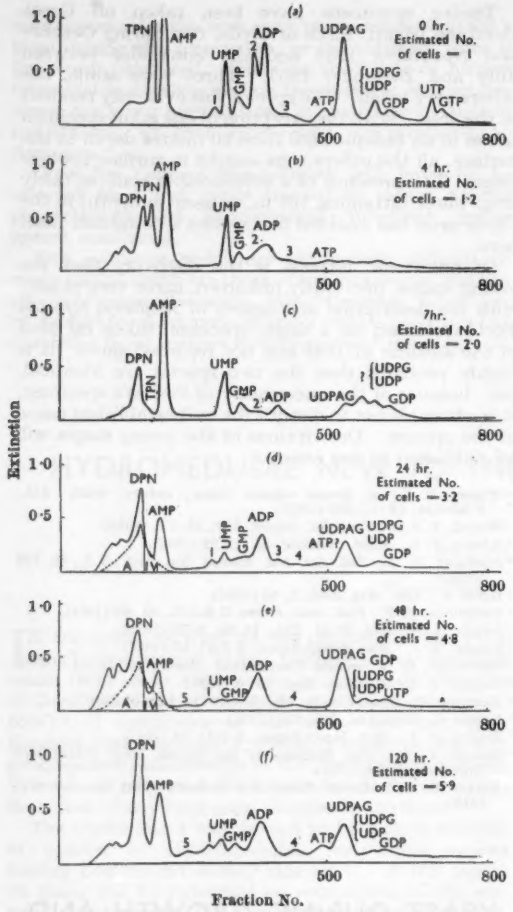


Fig. 1. Key: *A*, adenosine; *G*, guanosine; *U*, uridine; *MP*, *DP*, *TP*, mono-, di-, and tri-phosphate, respectively

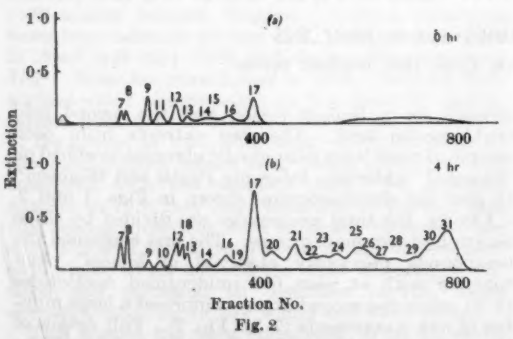


Fig. 2

Figs. 1 and 2. Chromatograms obtained by elution of yeast nucleotides from 'Dowex'-1 (chloride) in a calcium chloride–hydrochloric acid gradient (ref. 5) and determination of the absorption of ultra-violet light in the eluted fractions (each of 10 ml.). Samples of yeast (30 gm.) were removed from the medium after intervals of 0, 4, 7, 24, 48 and 120 hr., and each sample was extracted initially with aqueous ethanol and finally with cold trichloracetic acid. The extracts were chromatographed individually and the substances responsible for the peaks identified tentatively by means of their positions on the chromatogram, behaviour on paper chromatography, and isolation as their calcium salts (ref. 5) and determination of the absorption characteristics for ultra-violet light of the regenerated nucleotides under acid and alkaline conditions

coincides with a fall in the amounts of the nucleotides originally present, a fact which suggests that the nucleotides soluble only in trichloracetic acid are formed at the expense of the compounds soluble in alcohol. That the components soluble in acid appear during the synthesis of nucleic acids further suggests that they are intermediates in this process. In this connexion it is relevant to note that Ogur *et al.*[6] and others[7] have shown, using budding yeast and other organisms under selected conditions, that deoxyribonucleic acid is synthesized before cell division occurs. In addition, the participation of intermediates adsorbed on 'template material' and released only by treatment with acids has been inferred by Miettinen[8] and by Cowie and Bolton[9]. Furthermore, Okazaki and Okazaki[10] demonstrated that certain polymeric deoxyribonucleotides, separable on 'Dowex'-1 (formate), are active growth promoters in the presence of thymidine for a thymidineless strain of *Lactobacillus acidophilus* by virtue of their participation in the synthesis of deoxyribonucleic acid.

The selective extraction of the compounds soluble in acid mentioned above from yeast would appear to offer a means whereby they may be concentrated, separated and investigated structurally. Obviously, their isolation in useful quantity is best attempted at a critical early point in the development of the cell culture as their amounts decline rapidly after active growth sets in, possibly because they undergo rapid turnover during the subsequent life of the culture. In this connexion it would be desirable to study the changes in the nucleotide composition of synchronously budding cells, but adequate techniques for this purpose have still to be devised.

Finally, it has been found in the present work that many of the nucleotides, extracted by either hot or cold ethanol and separated by chromatography on 'Dowex'-1 (chloride), are associated with either peptides or sugars. Indeed, certain peptides at least are chemically bound to the nucleotides as in the case of a number of components located in zone *A* (Fig. 1*d* and *e*). Koningsberger *et al.*[11] have observed the presence of similar nucleotide–peptide complexes in bakers' yeast and, on the basis of the reaction of these substances with hydroxylamine to form hydroxamic acids, have suggested that they are intermediates in protein synthesis. The nucleotides which we have detected also react with hydroxylamine to form hydroxamic acids. While the precise nature of the peptide–nucleotide association remains uncertain (cf. Raacke[12]), it is perhaps significant that the compounds from yeast resemble in respects additional to their reaction with hydroxylamine the amino-acid adenylates containing a phosphoanhydride linkage[13]. For example, as mentioned above, they migrate towards the cathode on electrophoresis and, furthermore, they are eluted from 'Dowex'-1 (chloride) by means of sodium acetate solution at *p*H 5–7[13]. This latter property makes possible their separation from other nucleotides, particularly tri- and diphosphopyridine nucleotide (TPN and DPN) and adenosine monophosphate, which cannot be achieved by the procedure of Pontis and Blumson[5]. By employing this improved technique, coupled with chromatography and electrophoresis on paper, concentrates of the nucleotide–peptide compounds have been prepared in purified condition. One such complex, originally occupying section IV of zone *A* (Fig. 1*d* and *e*), unexpectedly proved on purification to have the ultra-violet absorption of the type given

by uridine, rather than adenosine, while on hydrolysis it yielded uracil together with a mixture of amino-acids in which arginine, cystine, glutamic acid and leucine predominated. In contrast to the acid-soluble nucleotides discussed above, the nucleotide–peptide compounds are readily obtainable at late stages of the cells' development. Structural investigations both on these compounds and on the above-mentioned intermediates in nucleic acid synthesis are in progress.

[1] Schmitz, H., *Biochem. Z.*, **325**, 555 (1954).

[2] Spiegelman, S., Halvorson, H. O., and Ben-Ishai, R., "Aminoacid Metabolism", edit. by W. D. McElroy and B. Glass, 124 (Academic Press, N.Y., 1955).

[3] Roine, P., Ph.D. thesis (Helsinki, 1947). Taylor, E. S., *J. Gen. Microbiol.*, **1**, 86 (1947).

[4] Pontis, H. G., Cabib, E., and Leloir, F., *Biochim. Biophys. Acta*, **26**, 146 (1957).

[5] Pontis, H. G., and Blumson, N. L., *Biochim. Biophys. Acta*, **27**, 618 (1958).

[6] Ogur, M., Minckler, S., Lindegren, G., and Lindegren, C., *Arch. Biochem. Biophys.*, **40**, 175 (1952).

[7] Lindegren, C. C., and Rafalko, M. M., *Exp. Cell. Res.*, **1**, 169 (1950). Lindegren, C. C., *Exp. Cell. Res.*, **2**, 305 (1951). Price, J. M., and Laird, A. K., *Cancer Res.*, **10**, 650 (1950). Swift, H., *Int. Rev. Cytol.*, **2**, 1 (1953). Pelc, S. R., and Howard, A., *Brit. Med. Bull.*, **8**, 132 (1952). Bullough, W. S., *Biol. Rev.*, **27**, 133 (1952).

[8] Miettinen, J. K., *Ann. Acad. Sci. Fennicae*, Ser. A, **2** (1954).

[9] Cowie, D. B., and Bolton, E. T., *Biochim. Biophys. Acta*, **25**, 292 (1957).

[10] Okazaki, R., and Okazaki, T., *Biochim. Biophys. Acta*, **28**, 470 (1958).

[11] Koningsberger, V. V., van der Grinten, C. O., and Overbeek, J. T. G., *Biochim. Biophys. Acta*, **26**, 483 (1957).

[12] Raacke, I. D., *Biochim. Biophys. Acta*, **27**, 416 (1958).

[13] Kingdon, H. S., Webster, L. T., and Davie, E. W., *Proc. U.S. Nat. Acad. Sci.*, **44**, 757 (1958).

PRESENCE OF A FACTOR INHIBITING BITING IN *AEDES AEGYPTI*

By M. M. J. LAVOIPIERRE

Department of Parasitology and Medical Entomology, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool

EVIDENCE has been obtained[1] that mated and unmated females of the Liverpool strain of *Aedes aegypti* (recently identified by Mattingly of the British Museum as *A. aegypti* var. *queenslandensis*) differ markedly in their avidity for blood. Whereas the mated females show a cyclical biting pattern which appears to correspond closely to the gonadotrophic cycle, the unmated females show no such cyclical biting activity, feed at a high level and lay few eggs. Gillett[2], who has studied ovulation in a Newala strain of *A. aegypti* (in which the unmated females, as in the case of the Liverpool strain, lay few eggs), showed that ovulation occurs a few days after mating; the factor responsible for this behaviour was named the ovulation hormone[3].

In the experiments described in this article at least two factors have been shown to be operative in the gonadotrophic-biting cycle. One of these appears to be identical with that previously described as the ovulation hormone[2,3], while the other is a hitherto unrecognized factor designated here as the 'biting-inhibitory factor'.

As in the earlier studies, the mosquitoes used were *A. aegypti* var. *queenslandensis*, the conditions under which the experiments were conducted being similar to those previously described[1]. Unmated females from a single 'pupal crop' were maintained on sugar water for four days and on the fifth day were offered a blood meal on a human volunteer. All the insects which had taken a full blood meal were then separated off into groups in cages, each group being offered a blood meal again on the sixth and seventh day. On the eighth day of the experiment, when the oocytes had reached the fifth stage, approximately three times the number of recently emerged males were introduced into each cage, mating being observed to occur almost immediately. Half an hour later the males were removed from the cages.

The effect of mating on the biting activity of the females was dramatic. Shortly after the removal of the males the arm of the volunteer was inserted for 10 min. into each cage, at intervals over a period of several hours. In all the experiments the percentage of mosquitoes biting fell steadily with time, and, in most cases, before a period of 2 hr. had elapsed, no mosquitoes would feed (Fig. 1).

In a further series of experiments observations were extended to a period covering several days. It was noted in these studies that the females (offered a blood meal for 15 min.) soon recovered from the biting-inhibitory effect produced as a result of mating, and that by the fourth or fifth hour (occasionally longer in some experiments) biting once more rose to a high level although all the females were fertilized

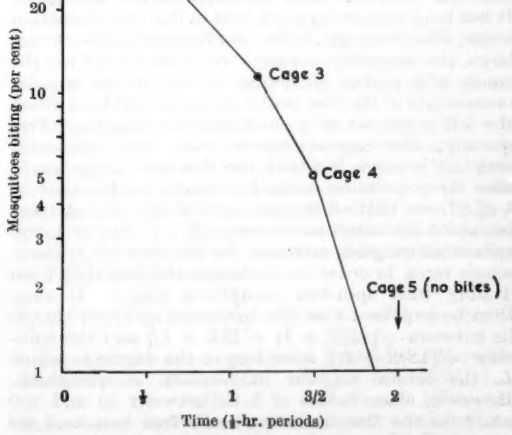


Fig. 1. Graph showing the effect of mating on the biting activity of previously unmated *Aedes aegypti* with fifth-stage oocytes. Each cage contained a group of 50–60 females. Whereas no males had been introduced into cage 1 (the control group), the females in the remaining four cages were mated; all the females were afterwards dissected. The results are plotted on semi-logarithmic co-ordinates

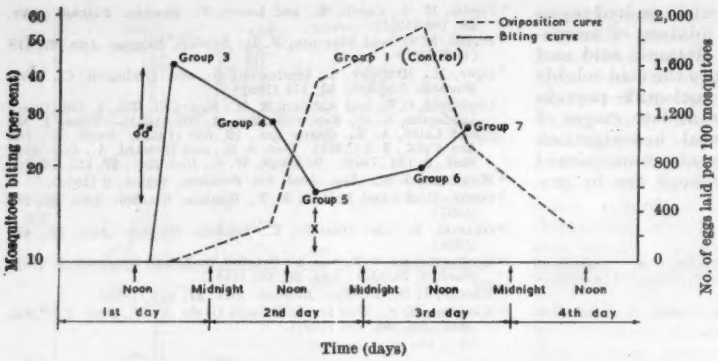


Fig. 2. Graph showing the relationship of the biting curve to the oviposition curve of a population of 520 female *Aedes aegypti* (divided into seven unequal groups) which were mated when the oocytes had reached stage 5. Group 1 (the control; indicated by the broken line) was used for the oviposition curve, while groups 2–7 (joined by the running line) were used for the biting curve, each group being dissected following feeding (group 2 does not appear in the figure because only one bite was registered). The biting curve records only the percentage of females (with fifth-stage oocytes) which fed; not until 5 p.m. on the second day (point *X* on the graph) were the first females found (8 per cent of group 5) which had laid all their eggs. The biting curve is plotted on semi-logarithmic co-ordinates and the oviposition curve on arithmetic co-ordinates

Although there was some variation in both series of experiments, the same pattern of behaviour was always repeated.

It seems evident from these observations that the biting-inhibitory factor is not the same substance as the ovulation hormone for, if this was the case, ovulation would be expected to follow at, or soon after, the disappearance of the inhibitory effect (4–5 hr. after mating). It therefore appears that in the normal gonadotrophic-biting cycle at least two factors, the production of which is dependent on previous mating, are involved. These two factors operate in harmony in the normal cycle[1], with the result that their individual identity cannot be recognized, but if mating is delayed until the fifth stage of ovarian development it is possible to observe the presence not only of the ovulation hormone[2,3] but also of that of a 'biting-inhibitory factor'.

(indicating successful mating), nearly all contained fifth-stage oocytes and no eggs had been laid. As is shown in Fig. 2, the peak of egg-laying activity followed some considerable time after the peak of biting activity.

[1] Lavoipierre, M. M. J., *Nature*, **181**, 1781 (1958).
[2] Gillett, J. D., *Nature*, **176**, 124 (1958).
[3] Gillett, J. D., *Ann. Trop. Med. Parasit.*, **50**, 362 (1956).

MAGNETIC PROPERTIES OF SPIN-FREE TRANSITION SERIES COMPLEXES

By Dr. B. N. FIGGIS
William Ramsay and Ralph Forster Laboratories, University College, London, W.C.1

THE magnetic behaviour of the sets of *d*-electrons which arise for the various transition element ions has received much attention in the literature. It has long been recognized that in the first transition series, where the spin-orbit coupling constants are not large, the magnetic moments which are found are the result of a partial quenching of the orbital angular momentum of the free ion by the ligand fields to which the ion is subject in a co-ordination complex. Frequently, the approximation that the spin-orbit coupling is much less than the thermal energy available for populating excited states is made—that is, $\lambda \ll kT$—so that all the members of the ground-state multiplet are taken to be occupied. (I employ λ, the spin-orbit coupling constant for the free ion spectroscopic term, in order to emphasize the fact that I am dealing with spin-free complexes only.) It may then be expected that the moments involved should lie between $\sqrt{\{4S(S+1) + L(L+1)\}}$ and the spin-only $\sqrt{\{4S(S+1)\}}$, according to the degree to which L, the orbital angular momentum, is quenched[1]. However, since values of λ lie between 50 and 800 cm.$^{-1}$ for the first transition series free ions, and are not much lower in actual complexes[2], and kT at room temperature is about 200 cm.$^{-1}$, it is obvious that such an approximation is unjustified. It is necessary to examine the ground-states of the ions in somewhat more detail in order to obtain a satisfactory account of the moments observed. This has been done in considerable detail for a few cases[3–6] and more generally for some others[7,8]. The purpose of this article is to summarize in a simple and easily utilized form the results available from the literature for the various d^n configurations and to complete the calculations for configurations not so available.

The ligand field to which a transition-element ion is subject in a complex may be classified, for the present purposes, as (1) strong if it is sufficiently large to force the pairing of electron spins; (2) medium if it is large enough to force the electrons to occupy 'private' d_ϵ and d_γ orbitals, provided they do not have to pair off spins to do so; and (3) weak if the spectroscopic terms of the free ion are maintained, although split into a number of components. A medium ligand field corresponds to the breaking down of the l–l coupling part of the Russell-Saunders coupling scheme for the free ion, a strong field to the breaking down of the *s*–*s* coupling part as well. For a great many co-ordination compounds the approximation that the ligand field is of entirely cubic symmetry is not unreasonable if it is desired to deal with the average magnetic properties of ions only, as distinct from the magnetic anisotropy. In this article the magnetic properties of all the d^n configurations will be outlined under this assumption for both medium and weak fields. The problem of strong fields under

this assumption has been dealt with[7]. In refs. 3 and 4 the magnetic anisotropy was of importance, and here we simplify the results to cubic symmetry. In ref. 8 the expressions for d^6 and d^7 in medium cubic fields are given; we make the simple extension to d^2, d^3, d^4 and d^8. Finally, the results of calculations on the weak field configurations of d^2, d^3, d^7 and d^8 are presented. Most of the information is presented in graphical as well as analytical form to facilitate the appreciation of its significance and its application to the interpretation of the behaviour of magnetic moment with temperature.

Griffith[8] has shown how the matrix elements of spin-orbit coupling and the magnetic moment operator may be obtained for all the medium field configurations ($d_\varepsilon^n d_\gamma^m$) by analogy with p^n configurations by

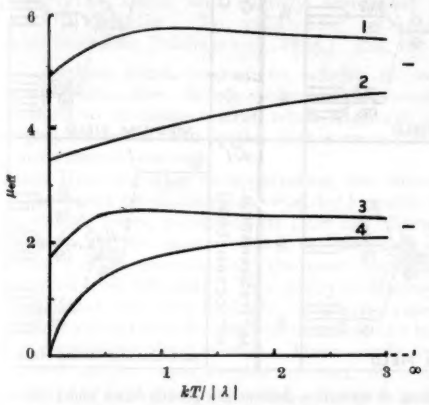


Fig. 1. μ_{eff} versus $kT/|\lambda|$ for ^2D: Ti^{3+} (octahedral, λ positive) and Cu^{2+} (tetrahedral, λ negative),

$$\mu_{eff}^2 = \frac{8 + (3x - 8)\exp(-3x/2)}{x\{2 + \exp(-3x/2)\}} \text{ with } x = \lambda/kT$$

^5D: Mn^{3+} (tetrahedral, λ positive) and Fe^{3+} (octahedral, λ negative)

$$\mu_{eff}^2 = \frac{3\{28x + 9{\cdot}333 + (22{\cdot}5x + 4{\cdot}167)\exp(-3x) + (24{\cdot}5x - 13{\cdot}5)\exp(-5x)\}}{x\{7 + 5\exp(-3x) + 3\exp(-5x)\}}$$

(1) ^5D, T_1; $d_\varepsilon^4 d_\gamma^1$, λ negative. (2) ^5D, T_1; $d_\gamma^3 d_\varepsilon^2$, λ positive. (3) ^5D, T_1; $d_\gamma^4 d_\varepsilon^1$, λ negative. (4) ^5D, T_1; d_ε^3, λ positive

There is no difference between weak and medium field cases

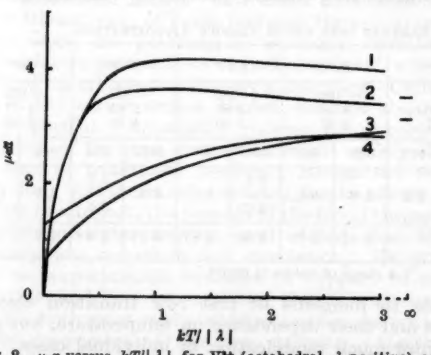


Fig. 2. μ_{eff} versus $kT/|\lambda|$ for V^{3+} (octahedral, λ positive) and Ni^{2+} (tetrahedral, λ negative). (*a*) weak field (^3F) and (*b*) medium field (d_ε^3 and $d_\gamma^1 d_\varepsilon^1$)

$$(a)\ \mu_{eff}^2 = \frac{3\{0{\cdot}625x + 6{\cdot}80 + (0{\cdot}125x + 4{\cdot}09)\exp(-3x) - 10{\cdot}89\exp(-9x/2)\}}{x\{5 + 3\exp(-3x) + \exp(-9x/2)\}}$$

$$(b)\ \mu_{eff}^2 = \frac{3\{5x + 15 + (x + 9)\exp(-2x) - 24\exp(-3x)\}}{2x\{5 + 3\exp(-2x) + \exp(-3x)\}}.$$

(1) ^3F, T_1; λ negative. (2) $d_\gamma^4 d_\varepsilon^4$, $^3T_1$; λ negative. (3) ^3F, T_1; λ positive. (4) d_ε^3, $^3T_1$; λ positive

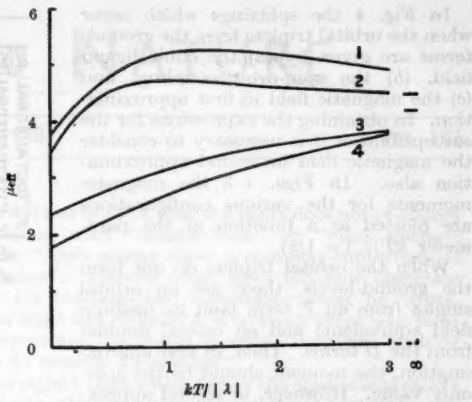


Fig. 3. μ_{eff} versus $kT/|\lambda|$ for Cr^{3+} (tetrahedral, λ positive) and Co^{2+} (octahedral, λ negative). (*a*) weak field (^4F) and (*b*) medium field (d_ε^3 and $d_\varepsilon^5 d_\gamma^2$)

$$(a)\ \mu_{eff}^2 = \frac{3(3{\cdot}15x + 3{\cdot}92 + (2{\cdot}84x + 2{\cdot}13)\exp(-15x/4) + (4{\cdot}7x - 6{\cdot}05)\exp(-6x)\}}{x\{3 + 2\exp(-15x/4) + \exp(-6x)\}}$$

$$(b)\ \mu_{eff}^2 = \frac{3\{5{\cdot}6x + 4{\cdot}32 + (3{\cdot}6x + 2{\cdot}347)\exp(-5x/2) + (4x - 6{\cdot}667)\exp(-4x)\}}{x\{3 + 2\exp(-5x/2) + \exp(-4x)\}}$$

(1) ^4F, T_1; λ negative. (2) $d_\varepsilon^5 d_\gamma^3$, $^4T_1$; λ negative. (3) $d\gamma^3 d\varepsilon$, $^4T_1$; λ positive. (4) ^4F, T_1; λ positive

means of arguments based on group theory. Alternatively, they may be obtained by direct calculation after the manner of Kotani[7], and the results set out in Figs. 1–4 were so obtained. For the D spectroscopic terms which arise for transition element ions there is no difference between the weak field and the medium field approximations. Penney and Schlapp[3] gave matrices for ligand fields of low symmetry for the F terms, which were not susceptible to exact solution in the general case. With the approximation of cubic symmetry, exact solution is possible, and this forms the basis for the weak field results for F terms quoted here.

From Penney and Schlapp it can be shown that the orbital wave functions of the T_1 orbital triplet (which lies lowest or highest according to the configuration and the sign of the ligand field) from an F term in a cubic ligand field are:

$$\psi_1 = \frac{1}{\sqrt{24}}(\sqrt{15}\langle 3| + 3\langle -1|),\ \psi_2 = \langle 0|,\ \psi_3 = \frac{1}{\sqrt{24}}(\sqrt{15}\langle -3| + 3\langle 1|),$$

where $\langle n|$ indicates the d-orbital wave function of the free ion with $M_l = n$. They are combined with spin wave functions corresponding to $S = 3/2$ for ^4F and $S = 1$ for ^3F. It is not possible to assign an effective value to L here, but it can be shown that for $kT/\lambda \to \infty$, $\mu_{eff.} \to \sqrt{\{4S(S+1) + 4{\cdot}5\}}$. For the medium field configurations ($d_\varepsilon^m d_\gamma^n$) the orbital wave functions corresponding to the weak field ones are:

$$\psi_1 = \langle -1|,\ \psi_2 = \frac{1}{\sqrt{2}}(\langle 2| - \langle -2|),\ \psi_3 = \langle 1|$$

taken with the same spin wave functions. Here the effective value of L, L', is 1 and $\mu_{eff} \to \sqrt{\{4S(S+1) + L'(L'+1)\}} = \sqrt{\{4S(S+1) + 2\}}$ as $kT/\lambda \to \infty$. These latter wave functions also apply to the orbital triplet T_2 resulting from the splitting of a D state by a cubic ligand field; here, spin wave functions corresponding to $S = \frac{1}{2}$ and $S = 2$ are required, respectively, for the ^2D and ^5D terms which arise.

In Fig. 4 the splittings which occur when the orbital triplets form the ground-terms are given by (*a*) the cubic ligand field, (*b*) the spin-orbit coupling, and (*c*) the magnetic field in first approximation. In obtaining the expressions for the susceptibilities it is necessary to consider the magnetic field in second approximation also. In Figs. 1–3 the magnetic moments for the various configurations are plotted as a function of the parameter kT/λ $(= 1/x)$.

When the orbital triplets do not form the ground-levels, these are an orbital singlet from an F term (and its medium field equivalent) and an orbital doublet from the D terms. Then, in first approximation, the moment should be the spin-only value. However, in second approximation the spin-orbit coupling, by connecting the orbital wave functions

$$\frac{1}{\sqrt{2}}(<2| - <-2|)(d_{xy}) \text{ and}$$

$$\frac{1}{\sqrt{2}}(<2| + <-2|)(d_{x^2-y^2}),$$

introduces the correction factors:

$$\mu_{\text{eff}} = \mu_{\text{spin-only}}\left(1 - \frac{4\lambda}{10Dq}\right) \text{ for } F$$

terms[3] and medium field equivalent

$$\mu_{\text{eff}} = \mu_{\text{spin-only}}\left(1 - \frac{2\lambda}{10Dq}\right) \text{ for } D \text{ terms}^6.$$

In Table 1 the moments derived from the free ion value of the spin-orbit coupling constant and the moment at room temperature are given under the approximations outlined above, and are compared with experimental moments for the ions concerned and with the spin-only moments and with $\sqrt{\{4S(S+1) + L(L+1)\}}$. It is seen that the fact that the moments mostly lie somewhat above the spin-only value is rather fortuitous, depending in a number of cases on the existence of a favourable value of the ratio kT/λ. When other values of kT/λ are arranged, as by performing magnetic measurements at low temperatures, it is to be expected that moments considerably above or below the spin-only value should be observed for certain ions.

For those ions where the difference between the medium and weak field moments at room temperature is significant the experimental results do not provide definite evidence of the superiority of one approximation over the other. This is anticipated on three counts: (1) the field-strength is likely to be intermediate between weak and medium, (2) the approximation of cubic symmetry is likely to fail in most complexes and (3) except where the ground-level is the 'non-magnetic' orbital singlet or doublet, the effects of spin-orbit coupling in mixing higher ligand field levels into the ground-level has been ignored, as also has the effect of bonding on the magnetic electrons. In this connexion it is necessary to repeat the warning given in ref. 8 against uncritical use of such formulæ; they should provide a valuable general guide to moments of first row transition element ions and their dependence on temperature, but may require much modification in individual cases.

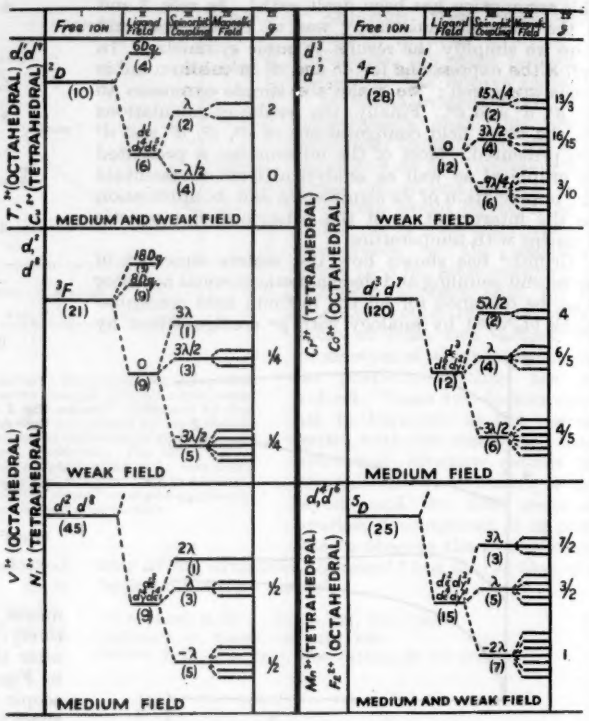


Fig. 4. Splitting of transition-element ion ground-terms under various approximations

Table 1. Magnetic Moments of First Transition Series Element Ions under various Approximations

Ion	Ti^{3+}		V^{3+}		Cr^{3+}		Mn^{3+}		Fe^{3+}		Co^{3+}		Ni^{3+}		Cu^{3+}	
λ (free ion) (cm.$^{-1}$)	154		105		87		88		−100		−180		−335		−852	
μ_{eff} (spin-only)	1·73		2·83		3·88		4·90		4·90		3·88		2·83		1·73	
$\sqrt{\{4S(S+1)+L(L+1)\}}$	3·00		4·46		5·20		5·47		5·47		5·20		4·46		3·00	
Stereochemistry*	oct.	tet.	oct.	tet.	oct.	tet.	oct.	tet.	oct.	tet.	oct.	tet.	oct.	tet.	oct.	tet.
μ_{eff} (weak field) (B.m.)	1·9	1·7	2·7	2·8	3·8	3·4	4·85	4·5	5·6	5·0	5·1	4·5	3·4	4·1	1·9	2·2
μ_{eff} (medium field) (B.m.)			2·7			3·7					4·7			3·5		
μ_{eff} (observed) (B.m.)	1·8		2·8		3·8		4·9		5·4†	5·3	5·0†	4·3†	3·2†	3·9	1·9	2·0?

* oct. = octahedral; tet. = tetrahedral. † A range of values is found.

[1] Van Vleck, H. J., "Theory of Electric and Magnetic Susceptibilities" (Oxford University Press, London, 1932).
[2] Owen, J., *Disc. Farad. Soc.*, No. 19 (1955).
[3] Penney, W. G., and Schlapp, R., *Phys. Rev.*, **42**, 666 (1932).
[4] Siegert, A., *Physica*, **4**, 1005 (1937).
[5] Howard, J. B., *J. Chem. Phys.*, **3**, 811 (1935).
[6] Polder, D., *Physica*, **9**, 709 (1942).
[7] Kotani, M., *J. Phys. Soc. Japan*, **94**, 293 (1949).
[8] Griffith, J. S., *Trans. Farad. Soc.*, **54**, 1009 (1958).

Supplement to NATURE

No. 4649 DECEMBER 6, 1958 Vol. 182

WILLIAM HARVEY AND HIS CRITICS

The Circulation of the Blood

Two Anatomical Essays by William Harvey, together with nine letters written by him. The whole translated from the Latin and slightly annotated by Kenneth J. Franklin. Pp. xxiii+184. (Oxford: Blackwell Scientific Publications, 1958.) 22*s.* 6*d.*

THE modern mind, trained to accept, at least tentatively, the latest scientific discovery, finds it hard to envisage a time when tradition was more highly regarded than truth. Yet it was so, even in the seventeenth century.

William Harvey, after demonstrating the circulation of the blood by experiments and by lectures for at least twelve years, published in 1628 his "Exercitatio anatomica de motu cordis et sanguinis in animalibus", often described as "the most important medical work ever written". Few believed Harvey's statements, and very few took the trouble to repeat his experiments in order to confirm or refute the new idea of a circulating blood-stream. Their minds were not attuned to the experimental method, of which Harvey was the first great exponent. Steeped in the teaching of Galen and the ancients, they failed to envisage "how such a circulation takes place without causing upset and mixing of the body's humours and destruction of traditional medicine", as Riolan expressed it. Any statement which contradicted the old and accepted views simply could not be true.

Harvey at first maintained a discreet silence and declined to be drawn into argument by his earlier critics. Only after a lapse of twenty-one years did he reply to the criticism of his friend Riolan in the "Two Anatomical Essays" now under consideration.

Jean Riolan, jun., of Paris, had sent Harvey a copy of his work on pathological anatomy, entitled, "Encheiridium anatomicum et pathologicum", which contained his criticism of Harvey's discovery. Unlike some of the earlier critics, Riolan was not abusive or disrespectful. Apparently seeking for a partial acceptance of the new idea which might satisfy the exponents of traditional medicine, Riolan did not wholly deny that the blood circulated, but he affirmed, or rather re-affirmed, the passage of the blood through the interventricular septum, and stated that the mesentery was devoid of any circulation. He produced no experimental evidence in support of his contention, and it is not surprising that this attempt to satisfy both sides really satisfied neither the critics nor the supporters of the new doctrine. Harvey begins his reply to Riolan with a graceful reference to the value of Riolan's book, mentioning his own interest in pathology, as shown in his writing on "medical anatomy", a work which appears to have been lost. He then proceeds to refute Riolan's statements, and to defend his original contention that "there is a circulation everywhere, and not restricted to certain parts". He admits that he has failed to discover the capillaries, but he now states, as he did not in 1628, that the heart does not re-charge the blood with "innate heat" or "vital spirits", adding "Such spirits show a common subterfuge of ignorance". Harvey must have felt how obstinate were his old-fashioned opponents when he wrote, "How hard and difficult it is to teach those who have no experience the things in which they lack such or have no sensible knowledge".

The eight letters which follow the anatomical essays to Riolan, though much shorter, are no less interesting. All were written during the last few years of Harvey's life, and they show his nobility of character and his gift of kindly friendship. To Nardi he wrote in 1653, "I am myself almost an octogenarian, and, although my physical powers are tottering with my body broken, yet with my mind active I give myself up gladly to studies of this sort", and to his Dutch friend, Jan Vlackveld, just before his death in 1657, he confessed himself "ripe in years but also—let me admit—a little weary" and "entitled to ask for an honourable discharge".

Prof. Kenneth Franklin, who embodies the unusual combination of a master of Latin and a professor of physiology (at St. Bartholomew's Hospital, where Harvey himself taught), made a most valuable contribution to the Harveian tercentenary celebrations last year by his translation of "De Motu Cordis" (see *Nature*, 180, 449; 1957). He has now added to his high reputation by giving us, in deft and elegant English, a modern translation of the essays to Riolan and the letters, under the title "De Circulatione Sanguinis", a fitting, and indeed essential, sequel to the earlier work, showing a more mature Harvey whose outlook had been ripened by years of further meditation and experiment.

"De Circulatione Sanguinis", 1649, is by no means a mere postscript to "De Motu Cordis", 1628, and perhaps it is unfortunate that the two books, bound together in what has been hitherto the standard translation by Robert Willis, now appear separately. Even the intelligent student, viewing them casually, might well regard them as the same book, so similar are they in format and title. The two are so intimately interwoven that they surely deserve to share one cover, and it is hoped they may do so in future editions. The Latin text forms the second half of the volume. Paper and printing are admirable, as also are the annotations and bibliography. Two rather rare illustrations show Riolan at work, and Harvey, in his later years, while a lovely coloured frontispiece of Charles, Prince of Wales, by William Dobson, commissioned by King Charles I and presented to Harvey, has been reproduced from the original painting in the Scottish National Portrait Gallery. Prof. Franklin has certainly revealed a new Harvey to the modern reader. His two delightful translations of the greatest of medical classics depict not only the discovery which inaugurated a new era in medicine but also the dawn of the experimental method and the demonstration of its value in the hands of the noble, erudite and intensely human William Harvey.

DOUGLAS GUTHRIE

PERCEPTION AND COMMUNICATION

Perception and Communication

By D. E. Broadbent. Pp. v+338. (London and New York: Pergamon Press, 1958.) 55*s*. net.

BROADBENT has written what is in many ways a most admirable book. Those who are interested in the analysis of human performance in the artificial environments created by technological advance will find in it a valuable and intelligent summary of the various subjects which have been investigated, many at the Medical Research Council Applied Psychology Unit at Cambridge of which Broadbent is the director. However, it would be misleading to suggest that he has given us a mere factual digest. He performs the difficult and unusual task of relating these findings in the applied fields to the problems which have traditionally been regarded as more fundamental, and shows with great skill that applied research does have theoretical importance. The field he covers in this process ranges from the effects of noise on human skill to latent learning in rats. Regarded as a review and a stimulant to thought, the book is first-rate. However, it can also be read as a theoretical contribution to general psychology. Here, Broadbent has many provocative and interesting suggestions. But there are various places where it seems that a more serious intellectual effort might have led the author to theories of greater depth. He tends to treat theories merely as different jargons; and this is what one might conclude from the way he uses them. His use of the terms of information theory, highly precise in their own context, is somewhat loose and without any clear purpose. His own filter theory is rather like the Freudian theory of memory. It accounts only for our failures while our successes continue by the same obliging miracle which has always served. One fears also that logically the filter theory resembles in many ways the explanations of faculty psychology. The abilities or properties of the whole man are explained by postulating entities each of which displays one of those abilities or properties. The statements of such theories are simple translations of the generalization which they are invoked to explain.

The interpretation of the experimental evidence necessarily precedes the framing of theories, as many results are not what they seem. Theorizing, particularly in psychology, is made difficult because the skill and hunches of experimentation are virtually impossible to convey to those who have not had practical experience. It is very easy to get the accent wrong. Animal experimentation is especially hard to evaluate. Though incomparably better than some of the engineers who have attempted to frame theories of animal behaviour, Broadbent's reviews and suggestions in this field are less felicitous than elsewhere. In his chapter on extinction the important problem of latent extinction is left untouched. Whatever the reason for this omission the experimental data in this field invalidate any such approach to learning or extinction as Broadbent's or Uttley's. The question of goal-extinction has been brought into prominence recently by Maltz, who attempts to solve it in Hullian terms.

Nevertheless, the shortcomings on the animal side are not serious for Broadbent's main thesis of filter theory, which must be judged by its usefulness in thinking about human performance. It might therefore be regarded as curious that no time is spent on the clinical material relevant to such subjects as attention or memory. A much firmer case could be made for the relevance of psychopathology rather than of animal psychology to Broadbent's ideas. Indeed, many of his problems are posed in an acute way in clinical psychology and the brilliance of Breuer's speculations concerning their solution has not been surpassed.

But perhaps these criticisms are not entirely fair. Broadbent in the book does concentrate mainly on the fields where he himself has made important contributions (with the exception of animal work). We cannot therefore reproach him too much for not attempting more. Secondly, it is not entirely clear for whom this book is written. The criticisms would apply in their full force if the book was meant to be a technical contribution. But taken as a more popular volume the force of any of the above strictures is largely lost, and we read with interest a scientist of imagination and intelligence writing about the many subjects to which he has made outstanding contributions.

J. A. Deutsch

EVOLUTION OF THE HUMAN MIND

Man's Emerging Mind

Man's Progress Through Time—Trees, Ice, Flood, Atoms and the Universe. By Dr. N. J. Berrill. Pp. xii+308. (London: Dennis Dobson, Ltd., 1958.) 21*s*. net.

THE Primates, feeding in the high, evergreen trees of warm, wet lands, could produce young at any season, but only one, or sometimes two, babies could cling to the mother as she climbed. They could make noises and groom themselves or one another without too much fear of the great cats below, ready to pounce. Swinging arms left legs freer for occasional and, eventually, persistent ground-walking, and the growing head and diminishing snout made this easier as the skull came to rest on the backbone—a very important matter as the brain grew towards its weight of 1,300–1,400 gm. The genes for snout-reduction seem rather specially linked with those for forward-looking eyes, and all these changes were such as Nature would select among groundlings. Development of hair is late in pre-natal life, and its competition with brain-development helped to make men's bodies almost hairless, with advantages in increased sensitivity and decreased parasites. The maintenance of hair on the head has proved valuable in protecting the brain from short-wave radiation, which would otherwise penetrate the thin skull of youth. Maintenance of head-hair led to its development as an ornament in women.

The decrease of body-hair helped, and was helped by, brain growth, at first subject to limits set by the birth-process, but, later, with fœtalization of the skull, continuing through an elongating infancy. Berrill hopes that further elongation of infancy, the trailing clouds of glory, as Wordsworth has it, is in store for mankind, and certainly the age of marriage has risen since Tudor times in Western Europe, and this has been a factor in intellectual activity and diversity of views.

The author might have further expanded the idea of skull growth to show that a decrease of ruggedness, and the early fixity accompanying that ruggedness,

helps to account for the 'Mediterranean' dolichocephalic race-character as an evolutionary change from hyperdolichocephals, often with strong brows, who linger among Australian aborigines and elsewhere. Too recent for this book is Dr. Oakley's provisional interpretation of finds as tools of Australopithecines; but, if this becomes established, tools contributed to early brain growth. The author follows general opinion in assigning some importance to sexual selection in mankind.

The book's rapid survey of civilizations emphasizes factors of climatic change very suggestively and, of course, tentatively. The southward spread, from a zone stretching between Mersin and Meshed to the lower parts of the twin-rivers, leads on to the rise of Sumer, a prime germ-centre influencing Egypt, India, Crete, Greece and probably China as well. The unity of Nature, including the whole man, is a leading theme of this book, so the author is in the succession from Spinoza and Goethe through such thinkers of our own culture as Lloyd Morgan, Smuts, Whitehead (whom he aptly quotes) and Alexander. All separatist curtains, whether iron or bamboo or brick, or linguistic or dogmatic, are a menace. Language can condition ideas, and pressures stultify inspirations. Freedom of critical thought and research is of prime importance. There are dangers in setting workers to do specified research tasks except in applications of science; science is more than its applications, and increase of understanding is to be sought along all possible paths, converging towards a goal that is always in the future. H. J. FLEURE

HUMAN STERILITY AND FERTILITY

The Reproductive Development of the Female

With Special Reference to the Period of Adolescent Sterility. By Prof. M. F. Ashley Montagu. Pp. xvii+234. (New York: The Julian Press, Inc., 1957.) 5 dollars.

Reproductive Physiology

Comparative Reproductive Physiology of Domestic Animals, Laboratory Animals and Man. By A. V. Nalbandov. (Series of College Texts in Agricultural Science.) Pp. xi+271. (San Francisco, Calif.: W. H. Freeman and Company; London: Bailey Bros. and Swinfen, Ltd., 1958.) 6.75 dollars; 58*s*.

BOTH these books come from the United States, and they both deal with different aspects of the subjects of sterility and fertility. The first is the more highly specialized of the two works. Prof. Ashley Montagu is an anthropologist as well as an anatomist and he has long been interested in a subject which has puzzled a great many anthropologists, namely, why girls who belong to primitive societies which grant a great deal of sexual freedom to their young people very seldom become pregnant. Malinowski directed attention to this fact in his book, "The Sexual Life of Savages" (published in 1929), after his return from living with the Trobriand Islanders. He writes: "It is very remarkable to note that illegitimate children are rare. The girls seem to remain sterile throughout their period of licence, which begins when they are small children and continues until they marry; when they marry they conceive and breed, sometimes quite prolifically. . . . I was able to find roughly a dozen illegitimate children genealogically in the Trobriands, or one percent". The young islanders shared sleeping mats in the communal sleeping hut to which they repaired at night: they knew nothing about contraceptive methods and they did not practise coitus interruptus. Why did the young girls so seldom become pregnant?

This is no longer a puzzle. Prof. Montagu, the author of the book under review, first published the results of his investigations of the subject in 1946 in a volume entitled "Adolescent Sterility". In the present book he adds fresh evidence of the existence, in all races, of a period of post-pubertal sterility. Previously, it was assumed that the establishment of menstruation was an indication that a woman was now able to procreate, but this is now known to be untrue. There is usually an interval of about three years before conception is likely to take place. It is also clear that even after women have passed this interval they are likely to be less fertile than they will become a few years later. There are several possible explanations of this period of relative infertility, the commonest being failure of the monthly ovulation and imperfect nidation of the fertilized ovum.

The human observations on this subject have been supplemented by similar observations on a number of different animals ranging from mice to chimpanzees. It is interesting to know that although exact observations on the adolescent male are more difficult to obtain, there are good reasons for believing that a similar period of sterility exists also in him. Prof. Montagu quotes Kinsey as stating in his report that "unpublished data gathered by the group study of sex behaviour at Indiana University indicate that there may be a period of some years of adolescent sterility in the human male". This idea is likewise supported by Webster and Young's investigation of the fertility of young male rats and guinea pigs.

Dr. A. V. Nalbandov, a lecturer in the agricultural sciences at the University of Illinois, in his book makes a very wide and complete survey of the subjects of fertility and sterility. His observations have been made on animals, but they throw light also on human fertility and sterility, and this makes his book of considerable importance to gynæcologists and medical men generally. In veterinary as in human practice, one of the difficulties which the research worker encounters is that the sterility or infertility problem is usually a multi-dimensional problem. That is to say, it is due generally to the existence of a number of different factors which may act singly but which usually react on each other so as to render breeding impossible. For example, female ewes which suffer from a reduced fertilizability of their ova often display an increased mortality-rate in the developing embryo. The problem to be dealt with is consequently often a highly complicated one.

Artificial insemination is being more widely used by veterinary surgeons, and Nalbandov attributes this partly to an extended use of semen diluters and partly to better facilities for the storage of semen. But there is a great difference in the viability of the sperms of different animals. While human, bull and chicken semen all withstand freezing at $-79°$ C. and prolonged subsequent storage, semen from a stallion cannot be subjected to this treatment. Indeed, stallion semen loses its fertilizing capacity at ordinary temperatures within forty-eight hours of ejaculation. This is unfortunate, for it makes impossible the use of artificial insemination where it would prove most convenient, namely, as a means of avoiding the

transport of valuable thoroughbred stallions. Although bull semen can be stored far better than stallion semen, there is reason to believe that "germ cells age and thus become physiologically less vigorous, and that their senility may be one of the main causes of embryonal mortality in both mammals and birds". Dr. Nalbandov stresses the importance of timing matings or insemination in domestic animals and in man "in such a way as to immunize the deleterious effects of the ageing of the ova and sperm cells".

Dr. Nalbandov's aim has been to give as full an account as possible of the "comparative reproductive physiology of domestic animals, laboratory animals and man", and the book he has written is the most complete work on this subject which the reviewer has, as yet, encountered. The various chapters contain many references to articles and books which provide departure points for further reading on these subjects. Both these new books should become standard works on their respective subjects.

Kenneth Walker

THE ARRHYTHMIAS

Rhythmusstörungen des Herzens

Systematik—Ursache und Klinische Bedeutung—Therapie. Von Prof. Konrad Spang. Mit beiträgen: Die Morphologie des Reizleitungssystemes, ihre Orthologie und Pathologie. Von Prof. W. Doerr. Physiologie der Herzirregularitäten. Von Dr. W. Trautwein. Pp. xvi+548 und ein Tafelanhang mit 228 Abb. (Stuttgart: Georg Thieme Verlag, 1957.) 148 D.M.

THE length of this book on a relatively circumscribed subject may at first alarm the reader, but he will be quickly reassured when he begins to study it, for it is clearly arranged and the style is lucid.

The author has set himself the task of re-awakening interest in the arrhythmias. After the initial enthusiasm following the appearance of Sir Thomas Lewis's book and that of Wenckebach and Winterberg, interest has lagged, since only a few arrhythmias are really of clinical importance. The author believes them to be often of greater clinical importance than is sometimes recognized to-day, but at the same time admits that in many cases the only reward of laborious study may be a better understanding of the disordered physiology.

To a British reader the collection of illustrative electrocardiograms at the back of the book, divorced from the text, is a drawback, since inclusion of a suitable illustration on the same page as the text makes for clearer exposition. On the other hand, diagrammatic representation of the mechanism of many of the complicated arrhythmias, such as parasystole, is included in the text and the notation of these diagrams could scarcely be improved, explaining at a glance what neither text nor electrocardiogram could convey simply. The diagrams of abnormal spread of conduction through the heart are also very clear and helpful.

The newer theories of the genesis of some of the arrhythmias, such as atrial fibrillation, are fully discussed. Rhythm changes during special cardiac investigations and during operations on the heart under hypothermia are briefly touched on. In addition, the chapters on treatment include more recent methods, such as the cardiac pace-maker and the defibrillator.

This book attempts to wed academic interest in the arrhythmias to fuller understanding of their clinical importance, and in this it largely succeeds.

J. P. D. Mounsey

TREATISE OF ZOOLOGY

Traité de Zoologie

Anatomie, Systématique, Biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 13: Agnathes et Poissons—Anatomie, Éthologie, Systématique. Premier Fascicule: Pp. viii+924. Deuxième Fascicule: Pp. viii+925–1812. Troisième Fascicule: Pp. vii+1813+2758. (Paris: Masson et Cie., 1958.) Chaque fascicule, broché, 12,000 francs; cartonné, 13,000 francs.

IT is ten years since the first volume (Vol. 11 in the series) of the "Traité de Zoologie" appeared, and now we have to welcome Vol. 13, the ninth to be published, which is devoted to the Agnatha and Pisces. The total number of volumes in the series is to be eighteen, so that approximately half the work has now been published although there may be rather less to come as some of the larger classes have already been dealt with. Zoologists the world over have come to know what to expect and to look forward to new additions to the treatise. The present volume, with its 2,758 pages, is so large that it has been divided into three almost equal fascicles, each as large as an ordinary volume, containing 924, 888 and 946 pages, respectively. As in all previous volumes, this one is generously furnished with illustrations which form an important part of the work.

The last text-figure is numbered Fig. 1889, but this is misleading and there has been some confusion in numbering, for Fig. 219 on p. 419 is followed on p. 434 by Fig. 245, and Fig. 1043 occurs on p. 1453 and again on p. 1471, so that the actual number is 1865. There are six plates in full colour. This, as in former volumes, does not give a fair impression of the wealth of illustrations, for a number of the figures contain several drawings which may even be on separate pages; for example, Fig. 378 occupies the whole of pp. 588 and 589 and nearly all of p. 590, Figs. 81 and 82 take up five complete pages and the best part of two more. These last two figures furnish excellent examples of a combination of line and colour, not common in text-books, but which in these and twenty-five others has been employed with telling effect. The great majority of the figures are line-blocks or half-tone or a combination of the two, and are on the whole very good although a few half-tones, for example, Figs. 720, 849, 1474 would be much improved if the background were cut out and the impressions were deeper. It is a pity that in the main systematic part (Fascicle 3) so many of the attractive illustrations give no indication of the magnification or reduction, nor is the size stated in the text. There is a certain lack of consistency in nomenclature, for example, sometimes *Lepisosteus* is used (deliberately) and sometimes *Lepidosteus*; sometimes *Scylliorhinus* and at others *Scyllium*.

Twenty-two authors, fifteen of them from Paris and each a specialist in his own field, contribute to the volume, thus ensuring an authoritative and up-to-date treatment. It has been customary for the authors to be chosen from French-speaking zoologists, but an

exception has been made in the present instance, and the section devoted to the ostracoderms, fossil cyclostomes (pp. 173–425 in Fascicle 1) is by an eminent authority on the group, Prof. E. Stensiö of Stockholm. This is probably the best general account of the ostracoderms available. It is well illustrated and contains, *inter alia*, a number of half-tone reproductions of actual holotypes. The magnification of the illustrations is almost invariably given, thus conveying an idea of size as well as appearance. There is a slip in the footnote on p. 256, where 'Dr. E. J. Whitte' is printed for what should obviously be Dr. E. I. White. The systematic treatment of the class Osteichthyes follows more or less orthodox lines, so that, as the fossil forms are included with the living throughout, the Crossopterygii come at the end. The last subdivision is a new super-order, the Actinistii containing the single order Coelacanthiformes, which has a single living genus *Latimeria*. While there are references to certain structures in *Latimeria chalumnae* (the only living species in the genus) in the general anatomical treatment of the bony fishes, the more extended account of it is to be found on pp. 2553–2597. The story of the discovery by Prof. J. L. B. Smith of this remarkable form is well known to all zoologists. The authors of this section are Prof. J. Millot and M. J. Anthony of the Natural History Museum in Paris, where there are ten well-preserved specimens. Not only is it a survivor of a group considered to have become extinct in the Cretaceous, but also the Crossopterygii occupy a most important systematic position. The coloured illustration on Plate V gives a clear impression of the appearance of the creature. The description covers a considerable amount of ground in a general way and is illustrated with good original photographs. In view of its rarity and great interest it is being thoroughly investigated by a team of workers, and a full account of this creature has only become available very recently.

Ninety pages of index and table of contents complete a volume which is well worthy of a place in a series widely known for its general excellence. It will remain indispensable for a long time.

C. H. O'Donoghue

TRANSPORT ACROSS CELL MEMBRANES

Metabolic Aspects of Transport across Cell Membranes

Edited by Q. R. Murphy. Pp. xxiv+379+11 plates. (Madison, Wisconsin: University of Wisconsin Press, 1957.) 7.50 dollars.

THE format, printing and production of illustrations in this volume are excellent, and the subject-matter summarizes a large amount of information concerning active transport in various tissues. Although the production of this volume was delayed, any notable advances made in the intervening time have been usually included in the proofs or as footnotes therein up to the year 1957.

Eleven formal papers were read, with intercurrent discussions with panel members at the symposium reported. It opened with a paper by Dr. E. F. Adolph on "Regulation in Fluid Exchange" with reference to the whole organism. He was followed by Dr. D. C. Darrow on "Some Aspects of Ion Exchange in Clinical Medicine". Dr. H. H. Ussing's communication was on "General Principles and Theories in Membrane Transport" and Dr. M. B. Visscher's on "Transport of Water and Electrolyte across Intestinal Epithelia".

In the section on ionic transfer in muscle and nerve, papers were read by Dr. E. J. Conway on "Membrane Equilibria in Skeletal Muscle and the Active Transport of Sodium"; by Dr. Silvio Weidman on "Transport of Ions across Cardiac Membranes"; and by Dr. A. M. Shanes on "Ionic Transfer in a Vertebrate Nerve". This was followed by a discussion with Drs. Fenn and Gerard, acting as co-chairmen. Dr. Fenn dealt with buffering mechanisms in relation to acidic treatment either of isolated amphibian muscle or after injection into the whole animal with particular reference to potassium, sodium and chloride exchanges. Dr. Wilde gave an account of his elegant 'effluograph' technique, with which the release of potassium in a single beat of the turtle's heart could be measured accurately. He also developed some clinical applications of the Conway theory. Dr. Brink communicated experimental results mainly concerned with the correla tion between loss of potassium and uptake of oxygen in frog nerve. Dr. R. Gerard put forward the views of Dr. G. Ling (who was unable to attend the symposium) with respect to the distribution of potassium and sodium ions inside and outside cells. This was answered by Dr. Conway, who had criticized Dr. Ling's views in his paper. This material was sent later to Dr. Ling, who replied, and a final rejoinder was made by Dr. Conway.

In the section on transport across renal epithelium, Dr. R. W. Berliner read a paper on "Some Aspects of Ion Exchange in Electrolyte Transport by the Renal Tubules". Exchanges of potassium, sodium and hydrogen ions were chiefly considered. The view that the carbonic acid system was responsible for urinary acidification was effectively dealt with, and acidification attributed to sodium and hydrogen ion exchanges. This agrees with the 'redox pump' theory, so named by Dr. Conway, which would in turn interpret the occurrence of carbonic anhydrase in the renal nephrons.

Reference was also made to the evidence pointing to the total re-absorption of the glomerular potassium in the proximal convoluted tubules, and its excretion of potassium lower down the nephron. In this context attention may be directed to the recent experiments of Dr. Morel (*Helv. Physiol. et Pharm. Acta*, 3; 1956) working with radioautographs of kidney slices after injections of labelled potassium, which appear to demonstrate elegantly such potassium exchanges.

A rather long and occasionally lively discussion followed, the panel members being Dr. Pitts (chairman) and Drs. Davies and Berliner. In this, Dr. Davies presented some new evidence with respect to potassium and sodium exchanges in kidney slices. This discussion was followed by another on the transport of organic compounds across renal epithelium, the panel members being Dr. Shideman (chairman) and Drs. Farah and Beyer. Experimental results of much interest were presented and discussed.

In the section on the secretion of gastric hydrochloric acid, Dr. Davies read a paper on "Gastric Hydrochloric Acid Production—the Present Position". Dr. H. W. Davenport read one on "Metabolic Aspects of Gastric Acid Secretion" and Drs. W. S. Rehm and W. H. Dennis presented "A Discussion of Theories of Hydrochloric Acid Formation in the

Light of Electrophysical Findings". A discussion followed, the panel members being Dr. Pitts (chairman) and Drs. Hogben, Davenport, Davies and Rehm.

In the discussion a lively controversy developed between Drs. Davenport and Davies concerning the true ratio of hydrochloric acid secreted to the oxygen uptake concerned therewith. It may be noted that both workers accepted a redox origin for the hydrogen ions, or the redox pump theory, but, whereas Dr. Davenport considered the upper limit of the ratio to be 4·0, Dr. Davies argued for its being greater than 4·0, with a back-feed of electrons. This controversy is dealt with rather fully by Dr. Conway in a paper on "The Redox Pump Theory and Present Evidence" at a symposium held at Saclay, Paris, 1958. From a new approach it was shown, using Davenport's numerous results with *Rana pipiens*, that it could be confidently concluded that in this species the upper limit of the ratio is 4·0, and the evidence for a similar conclusion from Davenport's mouse results is very strong.

The symposium ended with a discussion on the "Correlation of Clinical Problems and Basic Information relating to Membrane Transport". The panel members were Dr. Visscher (chairman) and Drs. Adolph, Elkington, Darrow, Streeten and Ussing. The chief contributions, with experimental results, were made by Drs. Elkington and Streeten.

BIOLOGICAL D-DAYS

The Ecology of Invasions by Animals and Plants

By Charles S. Elton. Pp. 181+50 plates. (London: Methuen and Co., Ltd., 1958.) 30*s*. net.

THIS is rather a deceptive book because at first it might seem little more than a lightly written, easily read and pleasantly produced account of some of the more outstanding consequences of introducing alien plants and animals where they do not belong. All this indeed it is, but it is also something much more because in the course of it Mr. Elton brings to the reader's notice more than one matter of prime biological importance. As he himself says in the preface, he has tried to bring together ideas from three different streams of thought: faunal history, ecology, and conservation, and on each of these he has something valuable to say.

In discussing the first of the three he develops the idea that before the Cretaceous not only were climatic conditions more generalized but also world-geography was more continuous, so that organic groups, as they evolved, more easily became world wide. Then and since, however, sea transgressions increased the isolation of continents so that each tended to develop its own fauna of birds, mammals and other recent groups. It is this continentality in distribution that is being so rapidly broken down by man to-day. Whatever the geophysical merits of this may be (and it is odd that there seems no mention of theories of continental drift) it is a piece of lively thinking and therefore welcome.

As an ecologist the author is chiefly concerned to make the point that the richer in forms and species a natural community is the greater the inherent stability it has and the better able it is to absorb shocks from outside. He rightly mentions tropical rain-forest as a supreme example of this. No doubt most biologists to-day realize, in some measure at least, that Nature is not a chaos of warring factions but a complex and delicate system of balances in which all share and to which all contribute, but this still cannot be too plainly stated and often repeated.

It is in considering conservation that Mr. Elton does his chief service—by putting fairly and squarely one of the really ultimate questions of biology, namely, what is going to happen when man has finally destroyed (as he certainly will, barring impediments) all the natural floras and faunas of the world. To get the right answer before this happens may make all the difference to the human race.

The book has some beautifully clear maps, but it is a pity that Mercator's projection is used for depicting distribution, a purpose for which it is most unsuitable. To take an example, the genus *Rhododendron* (Fig. 48) cannot possibly occupy, in continental North America, an area greater than that of the whole of Africa; nor is the gap between its North European and Asiatic areas equal to the distance from the Cape to Cairo.

RONALD GOOD

VIRUS STRUCTURE AND FUNCTION

Advances in Virus Research

Edited by Kenneth M. Smith and Max A. Lauffer. Vol. 4. Pp. ix+340. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1957.) 8 dollars.

THE dissection of viruses into their structural and functional entities has led to many exciting advances in current problems of virology. Although this volume begins with an excellent essay by Andrewes on the more philosophical topic of virus evolution, most of the contributions are concerned with various aspects of the anatomy and enumeration of virus particles and their mode of attachment and penetration into host cells.

The contributions by Hershey and Tolmach summarize much of the recent knowledge on the biochemical, genetic, structural and functional properties of bacterial viruses. Tolmach has admirably reviewed the mechanism of phage binding and the ensuing processes of 'penetration' and 'injection' of the viral deoxyribonucleic acid. This chapter is not specifically devoted to bacteriophages, yet it serves to emphasize how much more is known about their attachment and penetration than is known for animal viruses. One of the fascinating reactions outlined in Tolmach's article is the increased permeability following phage infection and the 'resealing' or reversal of this change in permeability. The favourable position of the virologist working with bacteriophages is further illustrated by the results of Benzer's experiments on genetic fine structure, mentioned in Hershey's review.

When we depart from the experimentally ideal situation where the ratio of particles to infective units is 1 (as with phages), the problems of measuring virus concentrations become more acute. The chapters by Isaacs and Yarwood make it abundantly clear that in inocula of animal and plant viruses, the particle counts greatly exceed the numbers of successful infections. With mechanical transmission of plant viruses, various treatments can increase the efficiency of infection. There seems to have been little attempt to seek an explanation for some of these effects. Indeed, at present there is no obvious explanation why such large numbers of animal and plant viruses are required to initiate an infection. As Isaacs

justly points out, blaming the failure to infect on "non-infective" particles or on "insusceptible" cells, falls into "the category of moral rather than scientific judgement". The enormous discrepancy between particle counts and infectivity titrations raises the problems of recognizing 'viruses' in the electron microscope. Pirie's chapter on the "Anatomy of Tobacco Mosaic Virus" will act as a refreshing antidote to those who infer that the size, shape and properties of the tobacco mosaic virus particle can be rigidly defined.

A diversion from the main theme on the structure, surface immunology and penetration of viruses is provided in the excellent chapter on the "Effects of Non-Ionizing radiations on Viruses" which, on the admission of the author, deals with effects on the biological activities of the virus rather than with any alteration of the component protein and nucleic acid parts.

The articles in this volume are presented in a lucid style, and they make good reading. There is, however, rather more duplication of information than one had hoped for. Virologists' addiction to 'the glossary' is amply illustrated in this book. The origin of this practice is difficult to justify as the terms used are those of general science. If a glossary proves indispensable, then I would at least prefer a non-classical presentation so that I should know, beforehand, the meanings of the terms to be used, rather than leave it until it was too late. M. R. J. Salton

AN INTRODUCTION TO PHYSIOLOGY

Cell Physiology

By Prof. Arthur C. Giese. Pp. xviii+534. (Philadelphia and London: W. B. Saunders Company, Ltd., 1957.) 70*s*. net.

WHAT is cell physiology? Since every organism is made up of cells, cell physiology could include the whole of physiology. If cell physiology is intended to cover what I would prefer to call the 'general physiology of the cell', it can be limited to those aspects of physiology which are common to all cells, such as water and salt relations, enzyme action in general, respiration, and, of course, the physical and chemical properties of protoplasm on which these processes depend. Prof. A. C. Giese, in his introductory chapter, makes it clear that what he calls cell physiology is of wider scope than this, for he says that the cellular physiologist is interested in nutrition, response to environment, growth and reproduction.

This would not seem to leave a great deal, but actually most of the book does deal with the general physiology of the cell, including the properties of protoplasm, cell division, cell membranes and the passage of water and dissolved substances through them, enzyme action and respiration. However, in line with Prof. Giese's wider conception of cell physiology, in a section devoted to nutrition, there is a chapter on photosynthesis which, although fundamental for nearly all life, is not to be regarded as within the scope of general physiology, since it is a function limited to the chlorophyll-containing cell. Again, a whole section of five chapters is concerned with irritability and response. Thus the title of Prof. Giese's book seems to me to be a little misleading; a title such as "An Introduction to General Physiology" might, perhaps, have given a better idea of its contents. Indeed, according to the preface, this is what it is intended to be, for we are told that the book is based on a set of lectures given at Stanford University and that logical sequels to the course are "classes in plant physiology, comparative animal physiology, mammalian physiology and bacterial physiology".

As an introduction to physiology the book undoubtedly fulfils its purpose. Physical and physico-chemical principles necessary for an understanding of physiological processes are dealt with adequately, and in this connexion the chapters on acidity and *p*H, and on temperature and life, may be particularly noted. As regards the discussions on the various aspects of cell physiology, I can call to mind no other book designed for students beginning to study physiology which gives such an up-to-date account of these. The book is clearly written and should be of value to the students for whom it is intended.

The illustrations are clear and adequate and many are original, but why is the picture of Brownian movement on p. 10 attributed to Steel's "Physical Chemistry and Biophysics" of 1928? This figure appeared in the late Sir William Bayliss's "Principles of General Physiology" published in 1915, where it was attributed to Perrin, whose original paper was published in 1909. W. Stiles

TEA

Tea

By Dr. T. Eden. (Tropical Agriculture Series.) Pp. xvi+201+73 Photographs. (London: Longmans Green and Co., Ltd., 1958.) 35*s*. net.

IT is not known when tea drinking commenced but it was a custom of China even before the Christian era. The Japanese took up tea drinking from the Chinese, and Arab traders brought a knowledge of it to the West. Jesuit missionaries brought a further knowledge of it to the West in the sixteenth and seventeenth centuries. The first arrival of commercial tea in London was between 1650 and 1655. Coffee drinking and the first English coffee houses date from about the same time. To-day the estimated consumption of tea in the United Kingdom is about 10 lb. per person per annum, while that of coffee is about 2 lb. A notable trend in recent years has been the great increase in tea drinking by some countries, especially by the local populations in many parts of the Indian subcontinent and Africa.

As up-to-date books on coffee (by Haarer) and cocoa (by Urquhart) have recently been written, it is fitting that one on tea should now appear. The author is familiar with tea production in many lands and has had a wide experience with the crop, first with the Tea Research Institute of Ceylon and later as the director of the Tea Research Institute of East Africa. All aspects of tea cultivation and preparation are dealt with by the author, and the fundamental agricultural and technological principles of the industry discussed. Much of the information presented is new or the result of recent research, particularly in such sections as those dealing with pests and diseases, manuring and vegetative propagation. The book is well written and well illustrated, and should prove of value wherever tea is grown, and as a reference work. Altogether a very great deal of information has been compressed into a comparatively small space. F. N. Howes

ENZYME KINETICS

The Chemical Kinetics of Enzyme Action

By Prof. Keith J. Laidler. Pp. vii+419. (Oxford: Clarendon Press; London: Oxford University Press, 1958.) 60*s*. net.

ENZYMOLOGY lies between the fields of physical and biological chemistry. Consequently, there is the need for a book to acquaint scientists from each discipline who are interested in enzymes with the basic principles of the other. In his preface, Prof. Laidler states that "this book has been prepared with the idea that it might be helpful to collect together some of the main results and concepts that have developed on the physical side". Because of this emphasis this book is, in the opinion of the reviewer, more suitable for the biochemist wishing to learn about the application of physico-chemical methods to the problem of enzymes than it is to a physical chemist interested in enzymology.

In the first chapter there is an elementary and limited introduction to enzymes for the physical scientist, and this is supported by some of the material of the final chapter concerning protein denaturation. Providing the reader does not expect to learn much about the biochemistry of enzymes from it, the book fulfils its purpose well.

The author is well known for his contribution to chemical kinetics, and in this volume he presents a clear and skilful account of this subject. The treatment is thorough, beginning with a sound introduction to kinetic principles followed by their application to very many interactions between enzyme, substrate and inhibitors. One topic which has been overlooked is a reaction between enzyme and substrate which occurs in more than two kinetically distinguishable steps.

It is regrettable that there is no standard nomenclature in the literature for the description of enzyme-catalysed reactions. Although the treatment in this book is generally consistent there are, unfortunately, a few examples of enzyme reactions for which individual algebraic analysis is required. The reciprocal of the Michaelis constant is used. This is advantageous in that it provides a direct measure of the affinity of enzyme for substrate; but it is unlikely that this change will be popular with many enzymologists. There are a small number of errors in the kinetic expressions, generally due to confusion between rate constants—for example, k_{-1} is sometimes written for k'_{-1}.

Forty-six pages are devoted to the important effect of hydrogen ion concentration on enzymatic activity. The theory is well illustrated by recent examples from the literature, though one might have chosen examples which have given kinetic data of greater precision. Such speculation makes interesting reading, but may, of course, be subject to revision in the light of new work.

The outstanding questions of enzyme action, efficiency and specificity receive brief but stimulating mention. Then follows a review of methods, kinetic and otherwise, which have been of assistance in elucidating enzymic reaction mechanisms.

The author devotes four chapters (110 pages) to a small number of the enzymes which have been subjected to most study, and reviews knowledge about them derived from kinetic and other evidence. The hydrolytic enzymes are treated in some detail; unfortunately, some of the tabulated data (for example, Tables 22 and 35) are not the best available. Many values given are now known to be in error. The oxidative enzymes and catalase and peroxidase receive brief mention. This review of current work is a difficult task in such a rapidly developing field, and it has not been assisted by the long time-lapse (two years) which appears to have occurred between completion of the manuscript and publication. This is partly compensated by including an appendix of references, some for 1958. Unfortunately, most topics can receive only a curt statement in this.

The emphasis in this volume has been placed on kinetic principles rather than individual enzyme systems, so that most chapters will not become too rapidly out of date. The book can be warmly recommended to biochemists; it is less suitable for physical chemists and others working in the field, although they, too, may find it useful to have as a reference book to specialized kinetic treatments necessary for enzyme reactions. B. R. Hammond

INSECTICIDES

Die Insektizide

Chemie, Wirkungsweise und Toxizität. Von Dr. Werner Perkow. Pp. viii+384. (Heidelberg: Dr. Alfred Hüthig Verlag, 1956.) 28 D.M.

THE author suggests that more research is needed at present on modern insecticides. He asks if enough is really done on a matter the results and progress of which are so essential to the basis of our food supply. Fundamental research work on insecticides is almost non-existent; but it could be decisive for the future efficiency of the pest control mechanism. The book is not a handbook in its strict sense, but the attempt to compile a German compendium on modern insecticides. Its disposition is somewhat uneven. For example, there are chapters named "Phenothiazin . . . " alternating with such titles as "Acarizide".

The chief stress in the contents is on chemical constitution, industrial manufacture, historical development and analytical methods. These subjects are discussed in a substantial form, the author himself being very familiar with them as an industrial chemist. The methods of application are described from the point of view of the insecticides, that is, the chapter on a specific insecticide tends to describe the manner in which this insecticide may be applied. On the other hand, the brevity of the book compared with the enormous extent of the whole subject leads to the result that the matter dealt with is limited: the book cannot be complete inasmuch as some minor subjects are omitted. For example, the reviewer missed calcium arsenite as well as the application to warm-blooded animals of systemic insecticides. But this fact is no vital fault of such an introduction; seen as such, the book is quite comprehensive in the subjects discussed.

However, in a very few cases the formulations of the text are not very convincing; for example, such a sentence as "Stored food protection is no simple problem and needs knowledge of the matter as well as responsibility" could have been applied similarly to other insecticidal matters. The chapter on bioassay methods is sufficiently comprehensive for an introduction, while the chapter on insecticide application by aircraft is too short for an English reader. It is a good idea of the author's to go into the subjects of toxicology and biology. Concerning these chapters,

it must be borne in mind that the author himself is neither biologist nor toxicologist. Thus some minor points regarding such matters do not show an exactitude comparable to that displayed in his own subject. But the author can be applauded for commending the plant insecticides, since they are less toxic than the synthetic ones. They are especially worthy of recommendation for the control of insects of medical importance or other insects living in inhabited buildings. Considering the shortness of some other chapters, that on historical development is somewhat long. The subject index at the end of the book is very comprehensive and undoubtedly useful.

WD. EICHLER

A SCIENTIFIC ANALYSIS OF FIXATION AND DYEING

Principles of Biological Microtechnique

A Study of Fixation and Dyeing. By Dr. John R. Baker. Pp. 357. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1958.) 45*s*. net.

WHEN the reviewer began learning the basic techniques of cytology and histology, it was believed that fixing and staining were more an art than a science: with the same material, the same fixative and the same stain, very different results were obtained by good and bad cytologists. For some reason, still mysterious, Unna's methyl green-pyronine always stains nucleic acids properly in Brussels and refuses to do so in many experienced laboratories elsewhere. It is the great merit of Dr. John Baker, who has been deeply impressed by the great work of Ehrlich—to whose memory the book is dedicated—that he has shown that fixing and dyeing are based on sound scientific knowledge: his book contains no practical instructions on how to make a microscopical preparation, but emphasizes "the principle that when we make a microscopical preparation of any sort, we ought to try to understand what we are doing, for otherwise we shall examine an unknown object that has been treated in an unknown way".

Dr. Baker's book is divided into two main parts: fixation and dyeing. In the first chapter, which is an introduction to fixation, the author emphasizes the differences between a fixative and a preservative, a coagulant and a non-coagulant fixative; he then discusses the question of artefacts. The next chapter deals with the visible effects of the reaction of fixatives with proteins (precipitation, flocculation, single clot formation, gel formation, etc.). The chemical changes produced in these reactions are the subject of Chapter 3: coagulants (sublimate, chromium tetroxide, potassium dichromate, acetic acid) are examined in this respect, and the differences between additive and non-additive fixatives are stressed.

In Chapter 4, Dr. Baker examines the reaction of fixatives with tissues and cells, partly on the basis of model experiments made on gelatine – albumin mixtures. Shrinkage and swelling during fixing and embedding in various media are discussed. In Chapters 5 and 6, coagulants (ethanol, picric acid, mercuric chloride, chromium trioxide) and non-coagulants (formaldehyde, osmium tetroxide, potassium dichromate, acetic acid) are considered individually from many points of view (standard concentration for fixation, description, ionization, redox potential, manufacture, introduction as fixative, reactions with proteins, lipids and carbohydrates, rate of penetration, shrinkage or swelling, effects on cell constituents, on dyeing and on the histological picture). Finally, in Chapter 7, twenty-five aqueous and two non-aqueous fixative mixtures are described and discussed.

Chapter 8, an introduction to the chemical composition of dyes, opens Part 2: chromophores and auxochromes are discussed, and pararosaniline, basic fuchsine, leucobases, basic and acid dyes serve as examples. Dyes are classified in Chapter 9 according to their chemical composition, while Chapter 10 deals with the more complex problem of the direct attachment of dyes to tissues: the role of the electric charges on the dye ions and on the objects dyed is especially stressed; the basophil or acidophil character of cellular constituents, apparent isoelectric point of the cell, the effects of washing with water or alcohol, the nature of the fixative mixtures used, etc., are examined in great detail. The subject of the next chapter is, by contrast, the indirect attachment of dyes to tissues (use of mordants, formation of lakes, differentiation, mechanism of Gram staining).

In Chapter 12, Dr. Baker discusses the differential action of dyes: depth of coloration is affected by chemical affinity, density and permeability; nucleic acids and collagen are chosen as the main examples. Metachromasy is examined in the next chapter, the emphasis being placed on Lison's theory. Blood dyes (Ehrlich, Romanowsky, Giemsa) are discussed in Chapter 14, while the two next chapters deal with vital dyes. Finally, dyeing is compared with other processes of colouring in the last chapter: substances which dye cell constituents by dissolving in them are called 'lysochromes' (for example, sudan III in the case of lipids); the principles of silvering and the use of fluorochromes are briefly presented.

The book ends with an appendix, in which the author presents a number of model experiments on fixation and dyeing, as well as a few notes on spelling: for example, he insists on the use of basiphil rather than the usual terms basophil or basophilic. Dr. Baker is probably right there, but he is almost certainly fighting a losing battle: scientists, as a rule, do not care enough about grammatical correctness and etymology to give up words which are in general use and understood by all.

The book is well written and well presented; the many German and French quotations (the latter not always perfectly correct) and the historical approach remind us of the fact that Dr. Baker is a true scholar. There is no doubt that his book will be useful to all those who want to understand what they are doing when they handle cells or tissues with 'classical' histological techniques.

J. BRACHET

MASS SPECTROSCOPY

Nuclear Masses and their Determination

Proceedings of the Conference held in the Max-Planck-Institut für Chemie, Mainz, 10–12 July, 1956. Edited by Prof. H. Hintenberger. Pp. ix + 267. (London and New York: Pergamon Press, 1957.) 84*s*. net.

THE conference, the proceedings of which are recorded in this book, was held to mark the sixtieth birthday of Prof. J. Mattauch, of the Max Planck Institute. He has himself contributed much

to the growth of mass spectroscopy, which during his life-time has become one of the most precise fields of physics, relative masses being determined in some cases to a few parts in 10^8. This accuracy and the wide number of techniques which are employed make the subject a testing-ground for the methods of several branches of physics. It is in such a situation that a conference can be the greatest stimulus to research, and the proceedings form a current review of the subject in all its aspects.

Since the previous conference on mass spectroscopy in 1951 much of the disagreement between mass values obtained by mass spectroscopes and by nuclear Q-value measurements has been resolved; however, there is still a significant disagreement in some cases, and much of the discussion concerned the possible sources of disparity.

The book opens with an authoritative review of the situation by K. T. Bainbridge, with a good list of references. This is followed by a short account of empirical mass formulae by A. H. Wapstra, and a study of the effects of shell structure on binding energies by U. Cappeller, mainly by a collection of graphs. A paper on the regularities appearing when beta-decay disintegration energies are plotted against neutron number was presented by K. Way, but without theoretical interpretation, and indeed this aspect was sadly lacking at the conference.

The next session comprised the latest mass spectroscopic results, with an excellent account by A. O. Nier on the work at Minneapolis. H. E. Duckworth described some recent determinations at McMaster University. It was unfortunate that L. G. Smith was unable to attend the conference to describe the synchrometer; a table of results was, however, included.

In the following session the measurements of nuclear masses obtained from nuclear reactions were outlined by W. W. Buechner and the techniques described by D. M. van Patter. It was apparent that results from the new large mass spectroscopes under construction will be matched in precision by accurate reaction measurements, over an expanding range of mass numbers. Results extending to titanium-45 were tabulated by P. M. Endt. In the region of heavier elements the method of determining mass differences by the total disintegration energies from beta- and gamma-decay schemes was described by A. C. G. Mitchell; considerably greater accuracy is attainable in suitable cases than by mass spectroscopic means.

The most stimulating session concerned the comparison between nuclear mass-values obtained from Q-values and from mass-spectroscopic doublets, and two very good contributions were given by J. Mattauch and D. M. van Patter. The sources of remaining discrepancies were closely examined, and the need revealed for further doublet measurements to bring the tabulated mass values to a uniform precision. The dependency of the reaction measurements on the calibration standards (such as polonium alpha-particles) requires a careful check to be made, while the work at the Massachusetts Institute of Technology must be augmented and confirmed by other laboratories.

Microwave spectrum measurements were reviewed by S. Geschwind in the following session. Very small amounts of material are necessary for this method, but the difficulty of preparing molecules of suitable symmetry and volatility is considerable and was not fully discussed.

The remaining third of the book is devoted to descriptions of instruments by the leading authorities: Nier (Minnesota), Ewald (Munich), Ogata (Osaka), Bainbridge (Harvard), Duckworth (McMaster), Hintenberger (Mainz) and Goudsmit (Brookhaven). An interesting idea for an electrostatic time-of-flight spectrometer was outlined by M. J. Higatsberger. This section is liberally illustrated with photographs.

The proceedings closed with three short contributions on standards for mass greater than 30 (H. E. Duckworth), the adjustment of mass spectrographs (F. Everling), and the precision of spectral line measurements (A. H. Wapstra).

The book as a whole is very clearly set out, with full lists of references for each paper, while the systematic arrangement of the contents almost makes up for the lack of an index. A summing-up of the proceedings by the editor would have made a valuable addition. With such an array of authors we have in this volume a very rounded account of the experimental side of the subject at the date of the conference. The list reveals, too, how Great Britain, after the brilliant work of Thomson and Aston, abandoned the field to the rest of the world. It is disappointing that no theoretical interpretation was presented of the many regularities and patterns revealed by the considerable precision now available. A method which shows so directly many features of nuclear forces, and can demonstrate so clearly in the packing-fraction curve the energy release by fission and fusion should, one feels, be worthy of more attention.

G. DEARNALEY

THE GRAVITATIONAL FIELD OF THE EARTH

The Earth and Its Gravity Field

By W. A. Heiskanen and Prof. F. A. Vening Meinesz. (McGraw-Hill Series in the Geological Sciences). Pp. x+470. (London: McGraw-Hill Publishing Company, Ltd., 1958.) 97*s*.

THERE is no modern book on the Earth's gravitational field and much of the literature is somewhat inaccessible and confusing; the publication of this book by the two foremost authorities on the subject is therefore most welcome. Throughout they take a broad view and relate the gravity data to the results of other branches of geophysics and to theories of the origin and development of the earth.

The book opens with an account of current views on the interior of the Earth. This is followed by a detailed discussion of the formal theory of the field of an almost spherical body, including terms of the second order of smallness. Nothing very original can be said on this topic, but the discussion is thorough and gives considerable numerical detail. It should be of permanent value as a critical and readable summary of the matter.

Chapter 4 discusses the instruments used for measuring gravity. Most types of pendulum apparatus and gravimeters are mentioned, but the descriptions are somewhat superficial. It would have been interesting, for example, to know how the creep of gravimeter springs has been reduced to the point where it is possible to measure gravity tides with an accuracy of one part in 10^9. A fuller description of the Meinesz pendulum apparatus for use in a submarine would also have been welcome, since the original and only detailed account has become a rare book. A clear

diagram is given of the complex system of fused quartz springs employed in the Worden gravimeter, including the arrangements by which the effects of variations in temperature are eliminated. The inventor of the instrument has for many years returned evasive answers to inquiries about this temperature compensation and it is pleasant at last to be told, at any rate in outline, how he achieves his remarkable results.

The next three chapters deal with isostasy. The methods of reducing gravity observations are described in some detail, and much numerical information is given about the degree of compensation found in various parts of the world. There has in the past been much controversy about the reality and generality of isostatic compensation. This controversy seems now to have subsided, and it is clear that the major features of the Earth's crust, the ocean basins, the fold mountains and the great plateaux are, taken as a whole, quite closely compensated, but that there are other features, such as the island arcs and the rift valleys that are not.

The last chapters discuss the causes of these deviations from hydrostatic equilibrium. This discussion is much more speculative than the rest of the book and is concerned with the downbuckling of geosynclines and island arcs and with the hypothesis that the driving forces are due to a system of convection currents. It is always difficult to produce conclusive evidence for or against a major geological theory, and it is perhaps unlikely that the theories of orogenesis, convection currents and polar wandering set out in this book will be generally adopted in the near future. It is, however, of great value to have a systematic account of their views by two authors who have done so much both to provide the data and to understand its meaning.

E. C. BULLARD

MECHANICAL VIBRATION

Engineering Vibrations with Applications to Structures and Machinery

By Prof. Lydik S. Jacobsen and Prof. Robert S. Ayre. (McGraw-Hill Series in Mechanical Engineering.) Pp. xii+564. (London: McGraw-Hill Publishing Company, Ltd., 1958.) 77*s.* 6*d.*

THE suppression and control of mechanical vibration have assumed great importance in engineering. One consequence of this is that the number of text-books on the subject is becoming quite large. But, so far as recent books are concerned, this one is unusual in that its authors have something fresh to say and the ability to say it clearly, simply and accurately. The book is meant to be an introductory one for engineers and, as such, it can be measured against the best. In its general layout the book follows the traditional pattern; the reader is led from the analysis of systems having one degree of freedom to systems with two-, then n-degrees of freedom and finally infinite freedom. Within this all-too-familiar framework, however, the book has some important features of its own.

There are two parts. The first of these deals with systems having one degree of freedom and, right from the start, an unusual degree of emphasis is placed on transient oscillation (in addition to steady-state and free vibration). The treatment of this topic is based mainly on phase-plane constructions and it is as lucid and technically entertaining as it is thorough.

A treatment of energy methods is given in this first part of the book, the single degree of freedom corresponding to motion in a single prescribed mode. It contains an elementary account, not only of Rayleigh's principle, but also of the Dunkerley and Southwell variants of it. It is unfortunate that the fundamentals have here to be dealt with in a rather superficial manner. This is more or less dictated by the academic level of the book, and the authors have therefore chosen to buttress the theoretical treatment with several examples. These are quite well chosen though some are rather complicated for the purposes of introduction. A better result might have been obtained by consigning some of the material to the place where it belongs—in the second part of the book.

The chapter on non-linear vibration is unusually readable. This is largely a result of the fact that the authors do not attempt too much. They firmly limit their treatment to two techniques, namely, graphical methods in the phase plane to cover transient and limit-cycle phenomena and the Ritz–Galerkin method for other steady vibration. The combination is shown to be quite satisfactory for the purposes of this book.

It is the reviewer's belief that writers on non-linear vibration seldom pay proper respect to the linear theory of dynamical instability (a subject which is not dealt with to any extent in this book). Thus, on p. 276 there is the statement that " . . . in a study of self-excited vibrations the non-linearities of the terms in the differential equations describing the motions are of paramount importance and . . . a neglect of them is inadmissible". This comment is partially redeemed in the summary of this chapter, but it is a little misleading since it implies that linear analysis is of no value where self-excitation occurs. This is, however, a minor point since the chapter in question is a first-class piece of writing. If the authors could be persuaded to dispel some of the hocus-pocus from other techniques of analysis in the same way, they would place non-linear vibration theory in a better position than it now occupies.

Part 2 of the book relates to linear multi-freedom systems, and the treatment is fairly simple. The authors do not use the Lagrangian equations, there is no discussion of damping, non-linearity is not introduced and emphasis is no longer placed on transient vibration (principal co-ordinates are not mentioned). Even so it cannot be said that this second part of the book is just a mass of familiar theory. For one thing some unusual topics are introduced—for example, the motions of buildings and the vibration of short beams—and for another the theoretical treatment of some topics is unusual. Thus the vibration of a conservative system with n degrees of freedom is the object of a rather unusual form of analysis.

Every chapter has a summary and a set of excellent examples. Many of the latter have answers given. There are also long lists of references which, so far as the reviewer can see, are mostly (though not always) well chosen from the enormous literature on vibration.

Perhaps the best way to describe this book is to say that it serves the same general purposes and can decently be placed on the same shelf as those of Den Hartog and Timoshenko. In other words, this book must be taken seriously. It has a less practical flavour than the former and has, rather, the more mathematical bias of the latter. But it does not duplicate Timoshenko's book by any means.

R. E. D. BISHOP

GEOPHYSICAL VOLUMES OF THE HANDBUCH DER PHYSIK

Handbuch der Physik

Herausgegeben von S. Flügge. Band 47 : Geophysik I. Pp. viii+659. 118 D.M. Band 48 : Geophysik II. Pp. viii+1045. 198 D.M. (Berlin : Springer Verlag, 1956 und 1957.)

THE new "Handbuch der Physik" will contain three volumes on geophysics, of which these two are the only ones so far published. Vol. 47 deals with the solid Earth, and Vol. 48 mainly with the atmosphere and oceans. Both volumes consist of a series of separate essays which between them cover most aspects of the physics of the Earth. Vol. 47 contains sixteen articles, and Vol. 48 seventeen ; nearly all are in English and a few in French or German.

Vol. 47 opens with an article by Spencer Jones on the rotation of the Earth. This is largely concerned with the fluctuations in the rate of rotation, the nature of which has become much clearer in recent years owing to the improved time-keeping possible with quartz oscillators and atomic clocks.

Seismology is treated in a group of six papers by J. Coulomb, K. E. Bullen, W. M. Ewing, F. Press and H. Baule. Much of the material is familiar, but the article by Ewing and Press on surface and guided waves gives much new data on a branch of the subject that is advancing rapidly and has been unjustly neglected in the past.

Gravity and isostasy are discussed by G. D. Garland, the structure of the crust by W. M. Ewing, the forces in the crust by A. E. Scheidegger, and the figure of the Earth by K. Jung. Scheidegger's discussion demonstrates how far from solution the major problems of geology still are. In spite of our greatly increased knowledge of what has to be explained, we are still entirely uncertain of the nature of the forces that mould the crust into mountains, island arcs and plateaux.

The longest article in this volume is that by J. T. Wilson, R. D. Russell and R. M. Farquhar on radioactivity and the age of minerals. This is a valuable review of a subject that has not been treated elsewhere in such detail. The use of radioactive methods of age determination should give a new precision and definiteness to the correlation of pre-Cambrian rocks, and a review by three authors who have done so much to make geological sense of the results is most welcome.

The remaining articles are by J. A. Jacobs on the interior of the Earth, by L. Caignard on electric currents in the Earth, and by S. K. Runcorn on the magnetization of rocks and the magnetism of the Earth's body.

Vol. 48 opens with a 154-page article by A. Eliassen and E. Kleinschmidt on dynamic meteorology. Most of this is devoted to general theory and to the properties and formation of vortices. The general circulation and the jet streams are dealt with only briefly.

There are four articles on radiation in the atmosphere, by F. Möller, W. K. Middleton, Z. Sekera and J. Bricard. The space given to this subject seems excessive in relation to the rather brief treatment of some important parts of the dynamical article. The related question of ozone in the atmosphere is treated by H. Paetzold and E. Regener. Other meteorological articles are on sound propagation in air by E. F. Cox, atmospheric electricity by R. Mühleisen, and the physics of clouds by F. H. Ludlam and B. J. Mason. The latter contains a striking photograph of the production of a towering cumulus cloud by seeding.

An article on meteors by A. C. B. Lovell gives a great deal of information that will be new to most readers, including a discussion of data on upper atmospheric winds derived from the motion of meteor trails.

The section on the oceans opens with a general review by H. V. Sverdrup and an article on waves by H. U. Roll. These are followed by four articles on tides. J. Bartels discusses and tabulates the tide-generating forces, and A. Defant, W. Kertz and R. Tomaschek discuss the tides of the oceans, the atmosphere and the solid Earth. Tomaschek's article contains information that is not otherwise easily accessible.

The book ends with an article by S. Sakuma and T. Nagata on physical volcanology. This is concerned mainly with the distortions of the Earth and magnetic changes associated with volcanic eruptions.

Clearly a very great effort has gone into the production of these volumes, and care has been taken to obtain a complete coverage of the subject. The result is a valuable reference work and a convenient means of learning about many matters in which there is widespread interest. Unfortunately the price is so high that few will be able to own the books, and Vol. 47 is so heavy (4½ lb.) as to be unreadable except at a table.

E. C. Bullard

PROBLEMS OF HIGH-SPEED FLIGHT

Aerodynamic Components of Aircraft at High Speeds

Edited by A. F. Donovan and H. R. Lawrence. (High Speed Aerodynamics and Jet Propulsion, Vol. 7.) Pp. xiv+845. (Princeton, N.J. : Princeton University Press ; London : Oxford University Press, 1957.) 120*s*. net.

THIS book is Vol. 7 of an important series of twelve volumes which is planned to give a comprehensive account of the problems of high-speed flight. Some of the volumes have already been issued, and of these Vol. 6, on the "General Theory of High Speed Aerodynamics", is of particular interest as the present volume is closely related to it. Whereas Vol. 6 treats the subject of high-speed aerodynamics in a fundamental and general way, the volume under review deals with specific problems such as the determination of the aerodynamic characteristics of particular parts of the aircraft and the interaction of one part on another

The book is arranged in seven sections, and in the first, Section *A*, R. T. Jones and Doris Cohen of the Ames Aeronautical Laboratory discuss the basic assumptions of wing theory and their validity. The results obtained by the application of various theories to the calculation of air load distributions at subsonic and supersonic speeds are compared and differences analysed. The material is conveniently presented in three chapters ; the first deals with fundamental considerations such as the use of sweepback in the development of wings for high-speed flight, and the second and third consider the prediction of lift and drag characteristics of the wings of various planforms at subsonic and supersonic speeds, respectively. The whole section runs to about 240 pages and gives a comprehensive account of the subject. It would

have made an excellent monograph on lifting surface theory if it had been published separately.

Section *B*, by Clinton E. Brown, of Langley Aeronautical Laboratory, deals with the problem of determining the drag, lift, and pitching moment of bodies, and concludes with a short discussion of stability derivatives for bodies of revolution. This section could and should have been more comprehensive; the latest reference cited was published in 1951. Consequently, many important developments of recent years are not discussed, and this chapter can only be regarded as a brief introduction to the subject.

The treatment of interaction problems by C. Ferrari, Politecnico di Torino, in Section *C* is, on the other hand, much more thorough and particular problems are considered in detail. Attention is mainly concentrated on the interference effect the wing has on the tailplane in subsonic and supersonic flow and the mutual interference of wing-fuselage combinations. A chapter of this section is also devoted to the treatment of propeller interference, including the influence of the propeller on the wing, the propeller and propeller-wing combination on the tailplane and the wing on the propeller. The whole section is well illustrated by diagrams giving comparisons between theory and experiment and extends to 270 pages. It ends with a long list of references, but none published later than 1954.

Section *D*, by C. B. Smith, of Pratt and Witney Aircraft Division, is concerned with the aerodynamic design of high-speed propellers, which are assumed to have thin blade sections and to operate at supersonic velocities. The problems are briefly outlined, and on the basis of two-dimensional strip theory the effect of blade section, planform taper and thickness distribution on the performance of the propeller are investigated. Diagrams to illustrate the effects of varying these parameters are given but no experimental results are included for comparison. The author ends his chapter with some brief remarks on practical structural considerations which must also be taken into account in the design of an efficient and reliable propeller.

In Section *E*, J. C. Evvard, of the Lewis Flight Propulsion Laboratory, briefly considers the problems of diffuser and nozzle design. The one-dimensional equations of flow are given in Chapter 1 and are used for describing the general characteristics of diffusion processes on the assumption that marked effects of laminar or turbulent flow separation are absent. It is emphasized that the real problem of subsonic diffuser design is to accomplish diffusion without separation. Methods of predicting laminar and turbulent separations are briefly discussed. Supersonic diffusion processes are considered at length, particular attention being paid to unsteady flow, 'buzz', in supersonic inlets and various causes of loss of pressure recovery. Some of the problems of exit nozzles and jets are briefly outlined in Chapter 2, such as thrust estimation of exit nozzles, the spreading characteristics of jets and the interactions of jets and after-bodies.

Non-steady wing characteristics are fully discussed by I. E. Garrick, of the Langley Aeronautical Laboratory, in Section *F*. He gives an excellent account of the state of knowledge of this subject up to about 1954. The basic theory is treated in some detail, and the exact solutions that have been obtained for two-dimensional flow are outlined. Transient flows are considered and growth of lift functions for subsonic and supersonic flows are given. Various approximate methods of calculating the load distributions on three-dimensional wings are briefly described and discussed. This section is entirely theoretical except for some concluding remarks on experimental methods for determining aerodynamic coefficients for oscillatory motion. A very long list of useful references to relevant theoretical and experimental work is included.

Finally, Section *G*, by C. W. Frick, of the Ames Aeronautical Laboratory, treats "The Experimental Aerodynamics of Wings at Transonic and Supersonic Speeds". This is a most interesting chapter as it compares theory with experiment and discusses the causes of discrepancies, where they exist. An attempt is made to assess the extent to which various theories can be used with confidence to predict air loads on wings at subsonic, transonic and supersonic speeds.

Progress in aeronautics is so rapid nowadays that any book of this kind unless it is printed very quickly is likely to be out of date in some respects when it is issued. The present volume gives the state of knowledge up to about 1954; but, although this is the case, it contains so much valuable information relating to the design of high-speed aircraft that it should be read with interest by all concerned with such work and by aerodynamicists generally.

W. P. JONES

COMPUTERS GALORE

Notes on Analog–Digital Conversion Techniques

Edited by Alfred K. Susskind. (Technology Press Books in Science and Engineering.) Pp. x+415. (Cambridge, Mass.: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1958.) 80*s*. net.

Computability and Unsolvability

By Prof. Martin Davis. (McGraw-Hill Series in Information Processing and Computers.) Pp. xxv+210. (London: McGraw-Hill Publishing Company, Ltd., 1958.) 58*s*.

Mathematics and Logic for Digital Devices

By Dr. James T. Culbertson. Pp. x+224. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: D. Van Nostrand Company, Ltd., 1958.) 36*s*.

Logic Machines and Diagrams

By Martin Gardner. Pp. ix+157. (London: McGraw-Hill Publishing Company, Ltd., 1958.) 39*s*.

Electronic Digital Computers

Their Use in Science and Engineering. By Franz L. Alt. (Applied Mathematics and Mechanics, Vol. 4.) Pp. x+336. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1958.) 10 dollars.

Reading in Linear Programming

By Dr. S. Vajda. Pp. vii+99. (London: Sir Isaac Pitman and Sons, Ltd., 1958.) 20*s*. net.

NOT only are computers themselves becoming so commonplace that more than 1,000 are in operation in the United States alone, but also the literature in the field, once so scant as to prove embarrassing to teachers and students of the art, is turning from a trickle into a deluge.

The present volumes are a fair example of the way in which publishers are attempting to meet the current interest, and they represent between them both analogue and digital computers, their design and their use.

To consider first the analogue field. The book edited by Susskind is devoted to a very small but increasingly important branch of the art : conversion between analogue and digital representations. There are some good things in the volume, particularly the sections on codes and coding and on optical devices, but the book is long for its content and savours too much of the lecture notes from which it was constructed. It is surely not too much to expect proper pagination and an index in a book of this price.

Davis's book is an attempt to explain, in self-contained and simple terms, the theory of computability pioneered by the late A. M. Turing. It is by no means an easy book to read ; but the difficulty is inherent in the theory, and the author has done well to make the subject as readable as he has. Applied mathematicians and programmers will be surprised, if they read as far, to find how complex and unintelligible a simple iterative process can become when handled by a pure mathematician and invested with the mysterious cloak of symbolic logic.

The book by Culbertson might well serve as an introduction to Davis's account. It contains some elementary topics such as notational concepts for sums and products, permutations and combinations, probability and number systems. Most of the book, however, is concerned with developing the elementary notions of symbolic logic and particularly of Boolean algebra as applied to switching circuits. The author writes very clearly, and his simple treatment of the synthesis of a reliable switch from unreliable components will come as a relief to those who have attempted to read the late John von Neumann's essay on the same subject. The author provides numerous examples for the reader and cannot blame the reviewer for summing up the book in the words of the author himself when he illustrates an ambiguous sentence (p. 103) : "I cannot recommend this book too highly".

On a less-exalted intellectual plane is Martin Gardner's book on logic machines. The author is noted in the United States as a writer on popular scientific topics, and he has succeeded in putting together a fascinating account of the history of these machines. The writing is clear and the illustrations well chosen and interesting. It seems likely, as the author remarks, that digital computers will replace special purpose logical machines, so that this book may well be the definitive epitaph to this subject. The reviewer has only one regret, which is that there are not more details of the mechanisms of the machines.

It is more difficult to give an opinion on Alt's book as the author himself is uncertain as to its purpose, claiming in one place that it is intended as an introduction to the design and operation of computers and in another that it is a book about computer specialists. In fact, the contents suggest a superficial tour through machines and applications rather than a solid account of either. It is very improbable that readers will gain much knowledge of the structure of computers and their components from the first section of the book, which relies exclusively on words and has no illustrative diagrams. In the same way, the section on problem analysis, although it covers a very wide range, proceeds in so highly condensed a manner that it would not be intelligible to a reader who was unacquainted with the topics discussed. The best part of the book is the last section, on computing laboratory organization, where the author's experience makes a valuable and authoritative account.

Last, but by no means least, is the little book by Vajda. This is concerned with problems the solution of which would only be possible, in the large, on a computing machine. The author's previous book dealt with the mathematical basis of linear programming and the present one formulates the systems of equations associated with a wide range of real industrial and sociological problems. Very little mathematical knowledge is required to understand the problems and their solution, and the book will be invaluable as a guide to industrialists and others who want to know how linear programming can be applied in their day-to-day work. It is perhaps unfortunate that the book has not quite the humorous qualities of William's "Compleat Strategyst" but humour in serious scientific books is a matter of taste, and readers may not share the reviewer's enthusiasm for it.

A. D. Booth

IMPROPRIETIES RESOLVED

Introduction to Fourier Analysis and Generalised Functions

By Prof. M. J. Lighthill. (Cambridge Monographs on Mechanics and Applied Mathematics.) Pp. viii+79. (Cambridge : At the University Press, 1958.) 17*s.* 6*d.* net.

IMPROPER functions, such as Dirac's δ-function which is zero everywhere save at the origin but has a non-zero integral over the range $(-\infty, \infty)$, have in the past been used in mathematical physics with much success and some coyness. Schwartz's theory of distributions, the origins of which may possibly lie in Volterra's pioneering work on functionals, has, according to Temple, "replaced the picturesque magic . . . by a self-consistent technique".

Generalized functions are defined as classes of equivalent sequences of ordinary functions, a process not unlike Cantor's mode of defining irrationals by classes of sequences of rationals. A calculus of generalized functions can be constructed without much technical difficulty, derivatives can be defined in a natural way (though products cannot be), and one great advantage is that there is much freedom in interchanging the order of limiting processes. This, as one might expect, simplifies the appropriate Fourier theory : delicate problems on uniqueness and convergence, the delight of the pure mathematician, disappear from a theory in which term-by-term differentiation and unique determination of the coefficients are practically trivial matters. The theory of Fourier transforms is correspondingly simplified, and follows very naturally upon the definition of generalized functions ; picturesquely, the Fourier transform of a periodic function is a row of δ-functions. It seems certain that mathematical physics can profit considerably from this new machinery—that the flexibility and directness of symbolic methods can now be exploited more confidently since their account at the bank of mathematical rigour is no longer 'in the red'.

Lighthill's monograph displays in seventy pages the general setting, the theory of generalized func-

tions, of Fourier transforms and Fourier series, with a particularly interesting chapter on the asymptotic estimation of Fourier transforms. The analysis is surprisingly simple, and should be easily intelligible to a reader with a good knowledge of the integral calculus and some small acquaintance with complex variable theory; the Lebesgue integral is not required. But the basic concept of a generalized function, which will be a novelty to many readers, must be thoroughly understood; the novice will do well to read and re-read the second chapter with great care, and he should not take even the simplest of the few exercises for granted. The good honours degree student with an interest in applied mathematics could readily master the book and derive great profit from his mastery. The exposition is concise, lucid and convincing. The dedication reads: "To Paul Dirac, who saw that it must be true, Laurent Schwartz, who proved it, and George Temple, who showed how simple it could be made". To this admirable summary we may add that Lighthill has made a good book of it. T. A. A. BROADBENT

MORLEY COLLEGE

Offspring of the Vic

A History of Morley College. By Denis Richards. Pp. xix+316+7 plates. (London: Routledge and Kegan Paul, Ltd., 1958.) 18*s*. net.

COFFEE and literature seem indissolubly linked—"It helpeth digestion and procureth alacrity", wrote Burton in his "Anatomy of Melancholy"—and from that time to the present-day *Partisan* in Soho, coffee houses have been the penny universities (as Aytoun Ellis described them in his book two years ago) and the clubs that served as therapeutic centres for the intelligentsia. Yet one more illustration of this indissoluble connexion has been provided for us all by Denis Richards.

The Coffee Music Halls Company was itself a blend of Arnoldian idealism (represented by Thomas Hughes and Dean Stanley, both old Rugbeians) and Ruskinism (represented by Emma Cons). Its one and only venture opened its doors on Boxing Day, 1880, in the former Royal Victoria Theatre, re-christened the Royal Victoria Coffee Hall for the purpose. Ballad concerts and lantern lectures lubricated with copious cups of coffee would, it was hoped, redeem the near-bordello character of the area. Purified variety and teetotal surroundings, however, could not keep the venture going, and so Emma Cons obtained the help of *Nature*. Through its columns she appealed to scientists to help her. This was in 1882, and by October 26 in that year she was able to tell readers that every Friday night more than 600 listeners attended lectures by W. L. Carpenter, Norman Lockyer and other scientific men of the day. "Stamps and whistles of impatience" greeted those lecturers whose apparatus broke down.

Rescued a second time by Samual Morley, a hosiery millionaire, and by the enthusiasm for polytechnics, it became Morley College on September 29, 1889. From then until the present day it has been one of the leading adult education colleges of Great Britain. It moved from the Victoria Theatre to 61 Westminster Bridge Road in December 1924, and during the 1930's, under Eva Hubback, most of the distinguished men and women of the decade came to talk. Music was its especial forte. On October 15, 1940, its second lease of life was ended when a 1,000 kgm. high-explosive bomb shattered 61 Westminster Bridge like a pack of cards, and since the Second World War one of its major battles has been to obtain a new building which, thanks to powerful friends, has been successful. The present warden, Mr. Denis Richards, tells the story with grace and insight and his re-creation of the gallant figures who have helped to build Morley College must be welcomed. It is an admirable prelude to the opening of the new buildings by the Queen Mother this autumn, and it will be welcomed by a wide cross-section of the reading public. W. H. G. ARMYTAGE

SECONDARY MODERN SCHOOLS IN BRITAIN

Secondary Modern Schools

An Interim Report. By Prof. H. C. Dent. Pp. xvi+207. (London: Routledge and Kegan Paul, Ltd., 1958.) 15*s*. net.

THIS is an exhilarating book by an assiduous, experienced, shrewd and sympathetic observer of the educational scene. Prof. H. C. Dent surveys the progress in Britain of what is generically called the secondary modern school since its birth, or rather baptism, in 1945, notes with examples the diversity of its evolving variations, reduces the bewildering diversity to the semblance of a pattern, and speculates upon the shape of things to come.

In the course of his description and appraisal of what is, he suggests, implicitly and explicitly, what might be if modern schools were disposed and able to give a general education "not focused primarily on the traditional subjects of the curriculum, but developing out of the interests of children" ("The New Secondary Schools"). This is the theory, indeed it might be called the philosophy, of the modern school conceived as a type. But as Prof. Dent makes abundantly clear, there are all sorts of reasons—pedagogical, psychological and social—why such a school has not emerged as the general type. It offers only one of the many acceptable curricular patterns for schools which are destined to educate so great a diversity of pupils and so large a proportion of the secondary school population.

This interim report on secondary modern schools is an admirable, lucid and just presentation of the schools that are forcing upon us a fundamental reconsideration of the secondary system. We shall not all agree with Prof. Dent's avowedly tentative speculation that the present secondary modern schools will eventually fall into two types: the 'special courses' and 'general certificate of education' schools on one hand, and the 'arts and crafts', 'projects' and 'interest-orientated' schools on the other. But we shall study with attention and respect his reasons for this prognostication.

In my view he attaches more importance than it warrants to the comparatively recent notion of a tripartite division of secondary education, against which the actual developments he so ably describes are in effect a protest. The developments that are going forward in the schools under review should lead us to discard the term 'modern' along with the rest of an outmoded and self-contradictory theory of

secondary education. It serves only to confuse the issue and create factitious problems.

When an educationist of Prof. Dent's reputation foresees the emergence of further types of school, the weight of his authority may do something to bring it about. It is to be hoped that he is wrong, since even if the infinite variety of pupils could be fitted into type schools with single-track aims, all 'types' of school could not be made available everywhere to all 'types' of pupil. Rather should we look to the possibility, within a broad conception of education at the secondary stage, of increasing variety within the schools. Instead of multiplying 'types', let us concentrate upon enlarging the capacity and resources of all schools to fit their curricula and methods to the needs of their pupils and thus enable them the better to do their job.

For an eminently readable account of the job the secondary modern schools are actually doing, their difficulties, frustrations and triumphs, we are all indebted to Prof. Dent. H. Raymond King

FUNDAMENTALS OF SYMBOLIC FORM

The Philosophy of Symbolic Forms

By Ernst Cassirer. Vol. 1 : Language. Pp. xiv + 328. (1953.) 40*s*. net. Vol. 2 : Mythical Thought. Pp. xviii + 269. (1955.) 40*s*. net. Vol. 3 : The Phenomenology of Knowledge. Pp. xvii + 501. 68*s*. net. All translated by Ralph Manheim. (New Haven, Conn. : Yale University Press ; London : Oxford University Press, 1957.)

IF an attempt is to be made to review what is, in effect, the essence of Ernst Cassirer's life and thought the only way is to treat these three volumes together, notwithstanding the fact that they have emerged from the Yale University Press at various times during the past five years. The translator has done adequately (and Cassirer could be extraordinarily subtle at times), while the historical and interpretative introductions enable Prof. Hendel to act as a welcome guide. The author was probably the last great thinker who could range over almost the whole field of human endeavour, and illumine it at every level. For it was nothing less that was required of anyone who set out to show not only the content but also the significance of symbolic form, whether in language, mythical thought or the phenomenology of knowledge. As specialization spreads more and more over the whole complex of man's activities (with the power that it brings to discovery and invention), so less and less likely does it become that a fair estimate can be made of the degree of mental adjustment which has been taking place in our awareness of those ultimate verities which can only be expressed symbolically. One has but to recollect the rapid advance in mathematics which followed the introduction of rational and consistent notations to see how potent a factor 'form' is : and not only visual form, but mental form, too, as it tends to crystallize out in clarity of exposition.

Vol. 1 (on language) is based upon the phenomenology of linguistic form and discusses the problem of language in the history of philosophy, then as a phase of sensuous and intuitive expression. After this comes the relation of language to conceptual thought, while the sphere of judgment is treated in the last chapter. Throughout Cassirer's work runs the thread of Kant's influence (and of the Neo-Kantian school at Marburg), strong at all times, but especially so when the "Critique of Judgment" is regarded as the interpretation of an epoch. Thus, three problems presented themselves as basic : first, the unity of empirical science, secondly, purpose in Nature, and thirdly, the nature of art. It is not difficult to see how paramount for an understanding of form is a system of communication—language—through which alone the search for natural law and man's own contribution can reach axiological stature.

Vol. 2 (on mythical thought) consists of four parts : myth as a form of thought ; myth as a form of intuition ; myth as a life-form ; and the dielectic of mythical consciousness. (Incidentally, the jacket of this volume carries the title "Mythical Thinking" instead of "Mythical Thought" as on the book itself.)

Of particular interest to the scientist is the discussion of number in relation to the formative period of mathematics. Philolaus (Fragment 11) says that "the nature of number is the cause of recognition, able to give guidance and teaching to every man in what is puzzling and unknown". Translated into psychological terms such as sensation, intuition and feeling, this brings numerical concepts very close to what the Pythagoreans meant by harmony ; and centuries later, Husserl, originally a pupil of the great Weierstrass, arrived at his 'structural forms', and through them at something like a calibration factor for the resolving power of the mind.

Vol. 3 (on the phenomenology of knowledge) is essentially a return, in expanded form, to the author's earlier (1910) conception of substance and function. But the emphasis this time is on structure and articulation, in fact a kind of ultimate analysis of a *Weltanschauung*. Three divisions are clearly discerned, namely, expressive function, representation, and the building up of scientific knowledge. Projected upon this wide intellectual horizon, the earlier volumes, concentrating upon language and myth, are seen at their true value.

To the scientist, the chapters dealing with the object of mathematics, and the system of modern physics will make substantial appeal. In the latter context, it is slightly unfortunate that for Cassirer 'modern physics' necessarily meant the quantum theory of the 1920's—a momentous but somewhat ephemeral phase, and not over-philosophical. What little weakness the translation has comes out here in slight idiomatic mistakes, such as 'ordinal number' for 'atomic number', and 'exponent of refraction' for 'index of refraction'. But a more fundamental matter is the author's strange omission of the *Axiomatik* of Carathéodory (1908), which must have been known to him when discussing the transition from the crude idea of heat to the modern conception of temperature.

Nevertheless, when all is said and done, these three volumes alone (apart altogether from Cassirer's other papers and books) make an outstanding contribution to epistemology and to the human power of abstraction. It is rather as if "The Golden Bough" had been written in philosophical rather than in historical terms. Scientist and humanist are more closely at one when the theme of knowledge is handled on the grand scale, than they are in the domain of specialized studies. Hand in hand they go, in the quest for an ever more perfect symbolic form, at once rigorous and aesthetically rewarding. F. I. G. Rawlins

Van Nostrand's Scientific Encyclopedia

Third edition. Pp. vii+1839. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: D. Van Nostrand Company, Ltd., 1958.) 220*s*.

THE third edition of this well-known work is impressively up to date. It is fresh, comprehensive and altogether a masterly production. The amount of material which has been compressed into the volume is really surprising. Five or more pages are given to many subjects, including television, transistors, carbon, computers, guided missiles, satellites, rockets, jet engines, nuclear reactions and reactors. There are also quite comprehensive accounts of subjects such as water, chlorine, perfumes and topical items such as titanium and radio-astronomy. The list could be greatly extended. There are more than 14,000 articles, covering mathematics, engineering, medicine and the physical and biological sciences. The work is very useful for the professional scientist as well as the layman. The topics covered extend even into specialized fields; on the mathematical side, for example, there are accounts of group representations and of Dirichlet integrals and their use in Fourier series.

In compiling a work of this character the decision what to include and what to exclude must be difficult. The reviewer hesitates to suggest additional topics, but must record his surprise at the omission of articles on information theory and on cybernetics. There is practically no mention of man-made fibres, and only two pages are given to quantum theory and one page to the subject of paper. An account of such topics would make the work larger than its present size. Even now, it is a little cumbersome to handle (it weighs 8 lb.). It would seem, therefore, that for future editions it would be a big improvement if the work could be split into two volumes.

L. S. GODDARD

Symposium on Protein Structure

International Union of Pure and Applied Chemistry, Paris Meeting, 1957. Edited by Prof. Albert Neuberger. Pp. 351. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1958.) 45*s*. net.

AN account has already been given of the purpose and scope of this Symposium (see *Nature*, **180**, 833; 1957). While its object was to assist the Protein Commission of the International Union of Pure and Applied Chemistry in defining 'purity' as applied to protein preparations, its programme was broadened to include many other topics of vital interest to protein chemists at the present time. The emphasis of the papers and discussions, now formally presented in this monograph, is upon the chemical aspects of structure, which include studies of amino-acid sequence and also the more challenging problems of chain-folding and topography of side chains. For certain proteins, all three aspects have been related in some measure to biological activity, especially in the case of the proteolytic enzymes and ribonuclease, and it is, perhaps, this manifold approach which fascinates most. It certainly marks a new phase in the chemistry of biologically active proteins.

Several chapters are devoted to techniques for the separation of proteins, some of which have been almost too successful and have revealed a disturbing micro-heterogeneity. Others emphasize the power of X-rays or of other physical tools to determine absolute structure or variations in it. With one or two exceptions, the contributions are commendably precise and digestible; even a rapid perusal will convince the reader he has been introduced to fields of intense activity and of great reward. The book is a sad reminder, however, that two of its distinguished contributors, Prof. Claude Fromageot and Dr. Rosalind Franklin, are no longer with us.

KENNETH BAILEY

Bacterial Fermentations

By H. A. Barker. (Ciba Lectures in Microbial Biochemistry.) Pp. vii+95. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 24*s*. net.

IN 1955, the Ciba Lectures in Microbial Biochemistry were established at the Institute of Microbiology, Rutgers University, and in the spring of each year since then a series of three lectures has been given by an invited speaker. The lectures are afterwards published, and so far three volumes have appeared, of which this is the first. Prof. Barker is well qualified to deal with bacterial fermentations since he and a succession of colleagues have made outstanding contributions in this field for more than twenty years. The author makes no pretence of being exhaustive but rather selects those aspects with which he personally has been most concerned.

The first chapter deals with methane-producing bacteria, some of the most difficult species to isolate and maintain in pure culture. Well-merited attention is given to the physiology of these organisms as well as to the chemistry of their fermentations. Then comes a description of butyric acid and butanol fermentations. This includes the brilliant work on the route of synthesis from ethanol of short-chain fatty acids in *Clostridium kluyveri*, an organism isolated by Barker. The last chapter is concerned with fermentations of nitrogenous compounds—amino-acids, purines and pyrimidines. The influence of Barker permeates every branch of this subject; it is good to have this lucid account, and it is fitting that his ability should have been formally recognized by the naming of a species after him—*Methanosarcina barkerii*.

KENNETH MCQUILLEN

Western Australian Wildflowers

Pp. 24 (22 coloured illustrations). (London: Angus and Robertson, Ltd., 1958.) 5*s*.

WESTERN AUSTRALIA is one of the world's flower gardens, noteworthy alike for the masses of coloured blossom that greet the eye in spring and for the curious shapes and vividly contrasting hues of so many of the flowers. The cover picture of this booklet presents the illyarrie (*Eucalyptus erythrocorys*) with the curiously contorted crimson operculate buds and golden yellow stamens of the open blooms outlined with the blue-green scimitar leaves and set against a blue Australian sky. Inside, a further twenty-one species are illustrated in colour, ranging from the kangaroo paw (*Anigozanthos manglesii*) strangely clothed in green and crimson wool, to the final picture of the sturt desert pea (*Clianthus formosus*), where a black glossy boss on the standard contrasts vividly with the scarlet petals. Proteaceae are represented by the scarlet banksia (*B. coccinea*) from King George's Sound and the curious sea-urchin (*Hakea laurina*) in which the flowers change gradually from cream to crimson. Other floral gems are the blue *Leschenaultia* (*L. biloba*) and the purple enamelled orchid (*Glossodia brunonis*). Mr. C. A. Gardner,

Government botanist for Western Australia, has written brief annotations to the pictures, all of which are good representations of the species they portray. The book should help to stimulate interest in the unique flora of Western Australie. It would make a charming small gift for any plant lover, whether botanist or layman. R. Melville

Amber Spiders in European Collections

By Alexander Petrunkevitch. (Transactions of the Connecticut Academy of Arts and Sciences, Vol. 41, July, 1958.) Pp. 97–400. (New Haven, Conn.: Connecticut Academy of Arts and Sciences; Copenhagen: Ejnar Munksgaard, Ltd., 1958.) 7 dollars.

IN this substantial monograph Prof. Petrunkevitch continues his study of amber spiders with an examination of 230 Baltic specimens, chiefly from collections in France, Germany and Denmark. Forty-seven new species are described, two of them belonging to families, Oxyopidae and Hahniidae, previously unknown in amber. The paper is illustrated by 591 text-figures, and the author gives reasons for preferring line diagrams to photographs: in this respect alone do his methods differ from those of former years. He emphasizes the great importance of labelling every piece of amber containing an arthropod with all the relevant data. The paper includes a list of all known amber spiders, of which 160 species are recognized and which belong to 27 existing and 6 extinct families.

T. H. Savory

The Chemistry of Borates

Part 1. A Review by Peter H. Kemp. Pp. viii+90. (London: Borax Consolidated, Ltd., 1956.) 12*s*. 6*d*.

THIS monograph is a valuable compilation of chemical and physical data on boron oxides, boric acid, and the borates of the alkali metals and of ammonium, calcium and magnesium. Five pages give the essential background on the element itself, and eight pages deal with the perborates, in which the author believes that there is no adequate evidence for hydrogen peroxide of crystallization.

Data in certain cases include enthalpy, entropy and free energy of formation, specific gravity, solubility, melting points, phase-rule diagrams, crystalline form, X-ray measurements, acidity constants and conductivity. Also, there are useful discussions on complexes with organic compounds and on aqueous solutions of the alkali borates.

The literature seems to have been conscientiously searched up to 1955. The book is well printed and no errors have been detected. A. D. Mitchell

Spot Tests in Inorganic Analysis

By Prof. Fritz Feigl. Fifth, enlarged and revised English edition. Translated by Prof. Ralph E. Oesper. Pp. xiii+600. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd.; Princeton, N.J.: D. Van Nostrand Company, Inc., 1958.) 65*s*.

THIS, the fifth edition of Prof. Feigl's well-known work, is a companion volume to "Spot Tests in Organic Analysis", and now appears as a book in its own right. Improvements and additions are reflected in an increase of the number of pages from 518 to 600.

The chapter by Prof. P. W. West on "Spot Test Techniques" now contains a description of the ring oven method of Weisz, which has been used for the separation of as many as 14 ionic species in a single drop of solution. Other additions include sections on cyanic, hypohalogenous, perchloric, and hyposulphurous acids, and on free aluminium, lead, zinc, tin, arsenic, molybdenum, vanadium, dicyanogen, and tellurium. Some of the twenty-five additional sections in the chapter dealing with the applications of spot reactions are concerned with, as examples, the detection of arsenic, manganese, nickel, titanium, and chlorine in minerals and rocks, the differentiation of calcite from dolomite, the differentiation of minerals containing barium and strontium, the detection of ammonium salts in filter papers, and the detection of iodine in mineral and sea water.

The book is now established as a standard work: due attention is paid to the chemistry of the tests and to the possibility of interferences. Perhaps, for the benefit of the inexpert, greater emphasis might have been placed on some parts of Chapter 1, for example, by italicizing the sentence on p. 14 which reads, "All experience shows that there are but few absolutely reliable and non-misleading tests".

C. O. Harvey

Abstracts of Papers

Given in the Session on Radiation Chemistry at the All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science, held in Moscow, March 25–April 2, 1957. Translated from the Russian. Pp. 47. (New York: Consultants Bureau, Inc., 1957.) 10 dollars.

THIS volume contains English translations of abstracts of papers given in the session on radiation chemistry at the conference on the application of radioactive and stable isotopes and radiation in the national economy and science held in Moscow in the spring of 1957. Fifty-five papers are abstracted, about 400 words being devoted to each. Nearly all aspects of radiation chemistry are represented, including the gas phase, aqueous and organic systems, polymers and metal corrosion, and there are several papers on special apparatus and techniques. The translations are excellent.

G. Porter

Symposium on Radiation Chemistry

Academy of Sciences of the USSR, Division of Chemical Science, Moscow, 1955. Edited by Prof. N. A. Bakh. Translated from the Russian. Pp. 223. (New York: Consultants Bureau, Inc., 1956.) 100 dollars.

THIS volume contains full translations of twenty-seven papers presented at the Moscow Symposium on Radiation Chemistry. In her preface Prof. Bakh says: "The symposium as a whole presents a picture of the modern development of various aspects of radiation chemistry in our country".

It is divided into two parts dealing, respectively, with transformations in aqueous systems and with transformations in organic substances. The first part contains investigations of the radiolysis of water, oxidation-reduction processes in inorganic salt solutions, sensitization and protection processes, the action of radiations on colloidal solutions, and a paper on radiolysis of liquid oxygen. The second part includes papers on the radiolytic oxidation of organic compounds, radiation polymerization, the actions of radiations on polymers and mass spectrometry.

The authors include P. I. Dolin, V. I. Veselovsky, the late N. B. Miller, N. A. Bakh, M. A. Proskurnin

and V. L. Karpov. The general standard is high, and the topics discussed cover most fields which occupy the minds of radiation chemists at present. The translations are excellent, and, although some time has elapsed since the papers were read, they provide a source of information on Russian work in this field which will be very valuable. Unfortunately, the language barrier has been surmounted only by the introduction of an equally formidable price barrier.

G. PORTER

Sourcebook on Atomic Energy

By Dr. Samuel Glasstone. Second edition. Pp. v+641. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: D. Van Nostrand Company, Ltd., 1958.) 34*s*.

DR. GLASSTONE'S book, prepared under the direction of the Technical Information Service of the United States Atomic Energy Commission, has been available for eight years and a new edition is therefore timely.

The book seems to have been re-set and is on whiter paper; but it has not lost its excellence as a source of scientific and historical information on nuclear energy. Though much of the text has been retained, it has been brought up to date in several respects: the anti-proton and anti-neutron are included, and more is reported on mesons. Unfortunately, the book just missed the complete declassification of thermonuclear research for the production of nuclear energy, though some of the information which was declassified at the time the book was written has been included. A new and very useful chapter is devoted to reactors; it is of the same high standard as the rest of the book, although the account of the considerable British power achievements seems rather short in comparison with their pioneering importance.

Though it is essentially a physics book, some data on the economics of nuclear energy would be valuable in a next edition.

This new edition stands in the forefront of books of its kind; it provides the 'intelligent layman's guide to nuclear energy'.

E. BRETSCHER

Introduction to Meteorology

By Prof. Sverre Petterssen. Second edition. Pp. ix+327. (London: McGraw-Hill Publishing Company, Ltd., 1958.) 52*s*. 6*d*.

FOR the second edition of a book written seventeen years ago Prof. S. Petterssen has gone to much trouble to provide a complete revision addressed to "students who are considering meteorology as a profession" and also to "students in geography, agriculture, aviation and various industries. . . .".

It is a serious and substantial book surveying weather science from instruments and observations through the basic physical processes to synoptic meteorology and world climate, and yet assuming for the reader a previous knowledge of mathematics and physics at first-year grammar school level. What can be done on this basis is quite remarkable provided that scientific explanation is restricted to the qualitative application of physical principles with an occasional simple formula, and, while it may be doubted whether specialist students of meteorology should begin in this way, there is no doubt of the demand for instructional text-books for the use of those much more numerous students whose interests lie primarily in other fields. The geographers, agriculturists, airmen and the like, who are not only interested in weather science but also may very well need to pass examinations in the subject, may count themselves fortunate in that one of our most eminent professors, now president of the American Meteorological Society, has made the effort to write in simple scientific language yet without any suggestion of writing down.

The book is indeed serious, for the author only twice allows himself a frivolous phrase. It is substantial and up to date although a little surprising in that so little is made of those parts of the subject to which the author has himself contributed so much: three-dimensional dynamical and synoptic meteorology. Possibly what one knows the best seems the least adapted to simple treatment. It is also not impossible to pick a few holes in the fabric. Thus I doubt if a small droplet has a high saturation vapour pressure because it resists the advances of vapour molecules in the air (p. 62); the statement that "normally the mixing ratio will increase from the ground upwards" (p. 84) is of course a slip; that "only a small part" of the solar energy is absorbed in the atmosphere and "the bulk is absorbed at the earth's surface" (p. 88) is an exaggeration of a ratio near 1 : 2; "if the oceans were still there would be little difference between the heat exchanges over oceans and over continents" (p. 95) is a remarkable assertion.

But criticisms of this trivial kind are the only ones which can be levelled against what is a reliable and informative introduction to the study of weather and climate suitable for the non-specialist.

R. C. SUTCLIFFE

The Science of Photography

By Dr. H. Baines. Pp. 319. (London: Fountain Press, 1958.) 38*s*. 6*d*.

ALTHOUGH Dr. H. Baines has written mainly for the non-scientist, any reader having little knowledge of the scientific background of photography will find that this book provides a good introduction to the facts and theories underlying all branches of the subject. The very wide field covered includes chapters on history, optics, the chemistry and physics of the emulsion, its preparation, characteristics and processing, colour photography, scientific and technical applications, etc.

This is a very readable book, which bridges the gap between popular articles, sometimes unreliable, on photographic theory and authoritative works unsuitable for the average photographer.

C. O. HARVEY

Introduction to the Theory of Determinants and Matrices

By Edward T. Browne. Pp. xi+270. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1958.) 60*s*. net.

THIS is a good book, well written and well printed. It covers the theory of matrices, including their applications to algebraic forms; and it covers that theory carefully and thoroughly. A novice reading it may find the going heavy, but the development, though sometimes severe, is logical, clear, and fully stated.

The book is aimed primarily at an American audience and "the text is intended for seniors or first year graduate students". In the author's view there is enough material for two semesters work. It would be a stiff course for the novice.

I have two minor criticisms of the book, both due to personal prejudices of my own: I dislike "it is clear that" and I hate small suffixes. Here argument after argument are admirably presented and then, suddenly, my pleasure is destroyed by a redundant "clearly" or "it is clear that". Finally, the print; the type and lay-out of the text and examples reach a very high standard of mathematical printing, but it has one serious fault. While numerical suffixes are excellent, well set and easy to read, the literal suffixes i and j are microscopic. Whenever I came to these suffixes in a close argument I had to reach for a 'spy-glass' to see which was which.

W. L. Ferrar

Combinatory Logic

Vol. 1. By Prof. Haskell B. Curry, Prof. Robert Feys and Prof. William Craig. (Studies in Logic and the Foundations of Mathematics.) Pp. xvi+417. (Amsterdam: North-Holland Publishing Company, 1958.) 42 guilders.

SOME thirty years ago, a new root stretched out into the very foundations of mathematics, or rather, of mathematical logic. This was the combinatory logic of Schönfinkel and Curry. Its particular task is the study of combinators, which are, in fact, a species of constant operator. In formal logic, one is accustomed to the notion of a variable; what is specific to the new discipline is the recognition that this is a complex concept, amenable to analysis. There is a connexion here (perhaps through Gödel's theorems) with the pre-conditions necessary for the design of antomata, and with Polanyi's heuristic field. There are chapters dealing with the several facets of the method, not excluding its bearing upon semantics and the limitations of language.

Where an essentially deductive element is invoked, especially in the use of quantifiers, the adjective 'illative' is introduced. This is a subtle derivation from the past participle of *inferre*, and is thus slightly apart from inference. The build-up of a formal system is well demonstrated for so simple a case as Euclid's "Elements".

Although the authors modestly disclaim any historical background, it is clear how far theorists have progressed beyond Aristotelian principles: they form but a trivial part of this imposing twentieth-century edifice. A great change in the structure of thought has set in, to bring about these highly specialized analytical techniques.

F. I. G. Rawlins

Inside the Comprehensive School

A Symposium contributed by Heads of Comprehensive Schools in England and Wales. Collected and Edited by the National Union of Teachers. Pp. 235+12 plates. (London: The Schoolmaster Publishing Co., Ltd., 1958.) 12*s*. 6*d*.

SOME at least of the dust raised by the introduction of the comprehensive schools in England and Wales is beginning to settle. Controversy still continues, but this is, generally speaking, more concerned with education and less with party politics than has all too often been the case. Even so, much of the argument is still tragically uninformed. Critics of the comprehensive school still talk of 'mass production', 'submergence of the individual', 'levelling down', and 'lowering of standards'. This timely little book has little to say by way of special pleading. Instead of argument it invites the reader to 'come and see'.

The seventeen contributors to this symposium are all heads of comprehensive schools. Their immediate concern is to describe how they are dealing with the practical problems of every day, the organization of varied courses, all flexible and interlocked, so that the curriculum can be fitted to the pupil instead of fitting the pupil to the curriculum; the breaking down of large numbers into small units, in which the pupil can feel at home, and where he finds personal understanding and appreciation; the pattern of external and internal examinations, which will provide for the vast majority some opportunity for achievement; the development of the social life of the school community; the problem of staff relations and the delegation of responsibility within the hierarchy; the relation of the school to its neighbourhood.

This is an interim report. There are less than fifty comprehensive schools in the whole of Britain, and only a few of these have had time to reach their full development. It will be another ten years before a final assessment can be made. No two comprehensive schools are exactly alike, but they are one in their conscious endeavour to provide the whole range of secondary education to suit the needs of the whole range of abilities from the candidates for open scholarships to the universities down to the educationally almost subnormal.

The writers are enthusiasts with a clear sense of purpose. They know what they are after and why, and for the reader interested in the 'why?' there is a summing up in the final chapter which may well give the hostile critic second thoughts.

Robert W. Fenn

Five Years' Work in Librarianship, 1951–1955

Edited for the Library Association by P. H. Sewell. Pp. viii+418. (London: The Library Association, 1958.) 60*s*.

"FIVE Years' Work in Librarianship" succeeds "The Year's Work in Librarianship" which ceased publication with the volume for 1950. Arranged in six sections covering, respectively, national and academic libraries, special libraries, public libraries, young people's libraries and library practice, with a miscellaneous section dealing with librarian co-operation, buildings, bibliography, archives, documentary reproduction, etc., it provides a competent and comprehensive survey of developments and trends in Britain and abroad. Information of special interest to the scientist or technologist is somewhat scattered through the chapters dealing with, for example, national libraries, university and college libraries, technical college libraries, medical libraries, industrial libraries, government libraries, the libraries of learned societies and professional bodies and the commercial and technical departments of public libraries. That even the chapter on library co-operation includes no reference to the lack of progress in the establishment of a national lending or reference library for science and techology is not, however, due to oversight on the part of the compilers, but to the strange lack of interest and support shown in the library world as in that of science and technology. So far as the service of science and technology is concerned, the picture is depressing, but a like survey over the two years following 1955 would provide fair evidence that the period of stagnation is past and that the needs of science and technology are now being faced with more imagination, vision and resource.

R. Brightman

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Method of fractionating High Polymers

WE wish to report the results of some exploratory experiments which have been attempted in order to establish a new method for fractionating high polymers.

Zone melting is now recognized as a method of producing materials having a very high degree of purity[1]. Used in the conventional manner, it is found that some impurities are more readily eliminated than others. If, in the case of a high polymer added to a solvent having a suitable melting point, the polymer is eliminated upon zone melting by a process dependent upon some physical parameter which is a function of the degree of polymerization, then this could be used as the basis of a means of fractionation.

In one experiment, a glass tube closed at the base, of 2·2 cm. internal diameter and 30 cm. length, was filled with molten naphthalene. This was first purified by raising the column slowly through a close-fitting heater supplied from a variable voltage source, and the voltage adjusted to give as narrow a molten zone as possible. There was considerable degassing during this process and also purification of the naphthalene, as evidenced by the decreasing opacity of the column after each pass through the heater. After eight passes there was little further change in the purity of the naphthalene contained in the upper portions of the tube.

200 mgm. of polystyrene (*D.C.P.J.*3, Distillers Co., Ltd., Epsom, Surrey. $\overline{M}_n = 80{,}000$, $\overline{M}_w = 200{,}000$) was put on the top of the column and taken into solution by arranging the heater and adjusting the heater voltage so that the upper 6 cm. was held in a molten state for 6 hr. This means that initially the polymer was present at 1 per cent concentration at the top of the column. A pronounced opacity, in a region which was formerly transparent, clearly indicated the position of the polymer when the naphthalene solidified. Zone melting was then carried out, using a rate of passage through the heater of 1 in./hr. After one pass it was estimated visually that the polymer had moved 3 cm. down the column, and so was dispersed throughout the upper 9 cm. Eight passes were sufficient to distribute the polymer throughout the whole of the column.

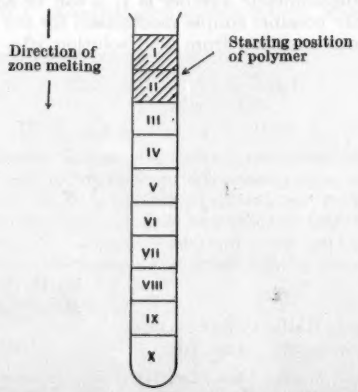


Fig. 1. The column used, showing the initial position of the polystyrene and of fractions recovered

Table 1

Fraction	I	II	III	IV	V	VI	VII	VIII	IX	X
Weight of polystyrene (mgm.)	8·0	7·0	7·5	8·1	6·8	6·4	7·2	6·2	46	106

The polymer was recovered by cutting out the polymer – naphthalene mixture with a flat-faced wood drill so as to produce ten approximately equal portions, and subliming away the naphthalene, which left the polymer in a very fine fibrous state.

The weights of the polymer recovered are given in Table 1, and the positions of the fractions on the column shown in Fig. 1.

The molecular weight and molecular weight distribution of each fraction were assessed qualitatively by turbidimetric titration[2]. In each case 35 ml. of the polystyrene solution, containing 4 mgm./100 ml., was placed in the titration cell, together with 10 ml. of dried methanol. The change in transmission of a light-beam passing through the cell was measured at 1-min. intervals while a further 10 ml. of methanol was added continuously at the constant rate of 0·135 ml./min.

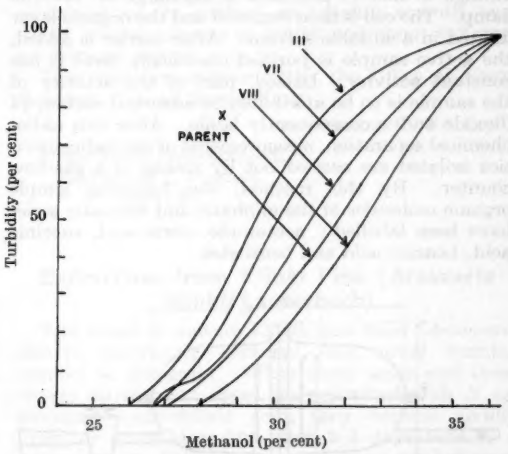


Fig. 2. Turbidimetric titration of the parent polymer and the polystyrene fractions in benzene solution using methanol as precipitant

Fig. 2 shows the change in turbidity of the cell contents with the addition of methanol. The parent material is precipitated over a wide range of solvent – non-solvent ratios, and the materials recovered from the column after zone refining show a much narrower range of precipitation; also the initial precipitation points move in a well-defined sequence.

From this experimental evidence, it can be concluded that the zone melting process can be applied to the fractionation of high polymers. Further investigation of the method is in progress.

F. W. PEAKER
J. C. ROBB

Chemistry Department,
University of Birmingham,
Birmingham 15.

[1] Parr, N. L., "Zone Refining", Royal Institute of Chemistry Monograph (1957).
[2] Melville, H. W., and Stead, B. D., *J. Polymer Sci.*, **16**, 505 (1955).

Production of Compounds labelled with Carbon-14 from Carbon-14 Dioxide accelerated in an Electric Field

It is well known that hot radioactive carbon-14 and tritium atoms can be used to produce labelled organic compounds often with very high specific activity[1]. This convenient method requires nevertheless a high neutron flux, often yields a cumbersome mixture of labelled compounds and moreover radiation damage frequently produces undesired effects. For these reasons, I have devised a new method in order to avoid such difficulties.

The procedure developed to prepare labelled compounds is based on the acceleration of carbon-14 dioxide by submitting it to a voltage of 500 V. Under such conditions, carbon-14 is able to react with organic compounds or radicals. In the apparatus illustrated in Fig. 1, the two steel electrodes are removable. A thin layer of the organic material to be treated (about 2–10 mgm.) is spread on the cathode. The two bulbs of the cell have ground-glass joints. The cell is connected to a vacuum line and evacuated for an hour to a pressure of 10^{-6} mm. mercury. After carbon-14 dioxide has been admitted at a pressure of $0{\cdot}5 \times 10^{-1}$ mm. mercury, an applied voltage of 500 V. produces a discharge of 100–150 μamp. The cell is then removed and the organic layer diluted in a suitable solvent. After carrier is added, the active sample is purified chemically until it has constant activity. Indeed, part of the activity of the sample is to be attributed to adsorbed carbon-14 dioxide and is consequently labile. After this radiochemical separation, measurements of the radioactivities isolated are carried out by means of a gas-flow counter. By this method, the following simple organic molecules of the aliphatic and aromatic series have been labelled: acetamide, citric acid, succinic acid, benzoic acid and benzoates.

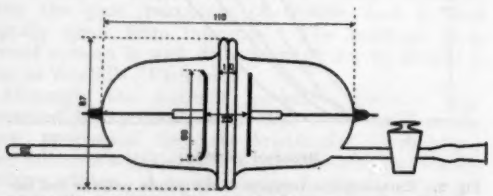


Fig. 1. Diagram of apparatus. Dimensions are in millimetres

In most cases, specific activities are equal to about 0·2 mc./gm. This procedure considerably reduces interference by other adjacent labelled compounds. The specific activities obtained are variable, depending on time of exposure, and increase with the latter. They are also a function of several other factors which are being examined in experiments now in progress. At the same time, the labelling mechanism will be studied. It is hoped that this new labelling technique will be applicable to other radionuclides.

I am indebted to Profs. G. Gueben and J. Govaerts, whose helpful suggestions and encouragement made this work possible. I acknowledge also grants from the Institut Interuniversitaire des Sciences Nucléaires of Belgium.

M. Guillaume

Institute of Nuclear Studies,
University of Liège. Sept. 30.

[1] Rowland, F. S., Turton, C. N., and Wolfgang, R., *Science*, **121**, 715 (1955). Rowland, F. S., and Wolfgang, R., *Nucleonics*, **14**, 58 (1956).

Hydrogen Overpotential on Germanium Electrodes

Electron transfer reactions at the semiconductor – electrolyte interface are of particular interest because it is not known experimentally whether the reaction kinetics depend upon the bulk electron concentration in the semiconductor. Results of recent measurements of the hydrogen evolution reaction on single crystal germanium electrodes are presented here. The electrode potential (versus the normal hydrogen electrode) was measured under suitable conditions of purity for analysis of the mechanism (Table 1).

Table 1. Hydrogen Overpotential Data at Germanium Electrodes (28° C. and 1 *M* Hydrochloric Acid)

Crystal surface exposed	Bulk electron concentration (cm.$^{-3}$)	Exchange current (amp. cm.$^{-2}$)	$-b$ (mV.)*	$-\Delta\varphi_{i=0}$ (mV.)†
Unknown	4×10^{14}	$1{\cdot}4 \times 10^{-3}$	113	45
Unknown	3×10^{18}	$4{\cdot}7 \times 10^{-4}$	102	1·5
(100)	$\sim 10^{18}$	$(2{\cdot}2 \pm 0{\cdot}3) \times 10^{-3}$	115 ± 12	29 ± 10
(100)	$\sim 10^{18}$	$(2{\cdot}3 \pm 0{\cdot}8) \times 10^{-3}$	109 ± 5	26 ± 6·6
(110)	$\sim 10^{18}$	$(1{\cdot}0 \pm 0{\cdot}2) \times 10^{-3}$	116 ± 2	35 ± 4
(111)	$\sim 10^{18}$	$(1{\cdot}9 \pm 0{\cdot}4) \times 10^{-3}$	148 ± 9	41 ± 20

* $b = 2{\cdot}303\ (\partial\eta/\partial \ln i)$ per decade of current.
† $\Delta\varphi_{i=0}$ is the rest potential of the electrode.

The case where care was taken to ensure that the crystallographic planes were the same on both *n*- and *p*-type germanium (third and fourth entries in Table 1) shows that variation in the bulk semiconductor electron concentration does not produce a corresponding variation in parameters of the hydrogen evolution reaction.

The fact that $\Delta\varphi_{i=0}$ is substantially above zero for most cases shown in Table 1 is interpreted as being due to the dissolution of germanium, that is, the germanium electrode is behaving as a polyelectrode[1]. Such polyelectrode behaviour makes it impossible to obtain the stoichiometric number, ν, for the hydrogen evolution reaction from an analysis of the overpotential – current curve as η goes to zero[2]. However, for one electrode $\Delta\varphi_{i=0}$ is essentially zero and here an analysis of the η versus i curve gives $\nu = 1{\cdot}06$.

Bockris (personal communication) has recently shown that a germanium electrode (supposedly the (110) crystal plane) is covered with a monolayer of adsorbed hydrogen atoms. When this fact is combined with the fact that the Tafel slope is $-2RT/F$ and the stoichiometric number is 1, it can be shown that the only possible simple mechanism for the hydrogen discharge reaction from acid solution is[2]:

$$H_3O^+ + e^- \xrightarrow{\text{fast}} GeH + H_2O$$

$$H_3O^+ + GeH + e^- \xrightarrow{\text{slow}} Ge + H_2 + H_2O$$

(Ge here indicates surface germanium atoms).

This presupposes the mechanism of the hydrogen evolution reaction to be the same on all the germanium crystal surfaces and that the germanium electrode is behaving like a metallic electrode. A more detailed discussion of this work will appear elsewhere.

V. R. Erdélyi
Mino Green

Zenith Radio Corporation,
Chicago 39. Aug. 19.

[1] Frumkin, *Z. phys. Chem.*, **160**, 116 (1932). Wagner and Traud, *Z. Electrochem.*, **44**, 391 (1938). Bockris, "Modern Aspects of Electrochemistry", 253 (Butterworths Sci. Pub., 1954).
[2] Bockris and Potter, *J. Electrochem. Soc.*, **99**, 169 (1952).

Macroscopic Surface Structures formed on Boron upon Solidification

THE purpose of this communication is to report some interesting surface structures that formed on a boron surface upon solidification from the melt. Melting was accomplished by electrical resistance heating of rods of polycrystalline boron about 1 mm. in diameter and several centimetres in length in a helium atmosphere. The current through the rod was slowly increased until it melted at the midpoint at about 2,000° C. and separated into two pieces, at which time heating ceased and the melted boron, held on the tips of the remaining pieces, solidified and cooled below red heat within a few seconds.

These rods were prepared by the reduction of boron tribromide by hydrogen on a tiny 0·025-mm. diameter tungsten filament at about 1,200° C. The main impurity in the rods was that of the tungsten core, which amounted to about 0·04 mole per cent. Emission spectrographic analysis indicated small amounts of calcium, iron, copper, magnesium and silicon amounting to a total of 0·02 per cent by weight.

The photomicrograph in Fig. 1 shows what appears to be a hexagonal spiral pit 0·4 mm. across. Several steps can be seen to extend from the outer edge of the spiral to the centre of the hexagon, where they then taper off and finally disappear. The electrical resistance at room temperature between two tungsten probes placed on the surface of the hexagon was about 50×10^6 ohms. Such a high resistance would be expected for boron but not for tungsten boride. A pyramidal pit approximately 0·1 mm. across at the surface and 0·1 mm. deep is shown in Fig. 2. Another structure observed (Fig. 3) was a highly reflective crystal face in the form of a parallelogram, which contained on its surface an equally smooth oval island several microns in height and about 0·2 mm. by 0·3 mm. across.

Fig. 1. Hexagonal spiral on boron (0·4 mm. across)

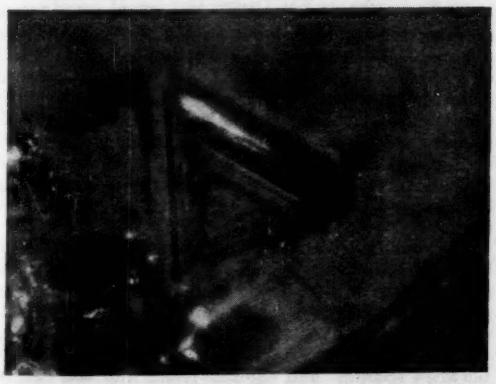


Fig. 2. Pyramidal pit on boron (0·1 mm. across)

Fig. 3. Oval plateau on boron (0·3 mm. across)

This work was supported by the Office of Naval Research, United States Navy.

CLAUDE P. TALLEY

Experiment Incorporated,
Richmond 2, Virginia.
Sept. 30.

Extractives from Klinki Pine (*Araucaria klinkii* Lauterbach)

THE wood of mature klinki pine trees (*Araucaria klinkii*) frequently contains pink areas running parallel to the grain. When these areas and those closely adjacent to them are moistened with *N* (or stronger) hydrochloric acid, they become vividly green or green-blue, but after 2–3 days fade to a brown colour. Other acids give either a weaker green colour on fresh samples of the wood or show no reaction. Of the other species of this genus the wood of parana pine (*A. angustifolia* O. Kuntze) frequently shows red-coloured bands, but these do not react in a similar manner when acid is applied to the surface of fresh samples. Dry wood of *A. bidwillii* Hook, *A. cunninghamii* Sweet, *A. excelsa* R. Br., and *A. montana* Bronger et Gris gave no response, but a weak reaction was shown by the woods of *A. cookii* R.Br. and *A. bernierii* Buchh.

When the pink wood of klinki pine was extracted in a Soxhlet with hot methanol, a colourless crystalline material (m.p. 235–38°, $\lambda_{max.}$ 256 mμ, yield 0–2·5 per cent) was soon removed, but the components responsible for the green colour reaction were very slowly removed. The yield of the latter varied between 1·3 and 3·4 per cent, with the smallest yield from the most brightly coloured samples, which also contained less crystalline material.

When the non-crystalline fraction, containing six major components (Table 1), was chromatographed on a cellulose column with 6 per cent acetic acid, compounds *B*—*E* were obtained in a total yield of

Table 1. Characteristics of Klinki Pine Extractives

Compound	R_F values in: 6 per cent acetic acid	Methanol–*iso*propyl–ether–water (ref. 2)	Ligroin–*n*-butyl ether–water (ref. 1)	Benzene–ligroin–methanol–water (*c*) (refs. 3 and 4)	Colour or fluorescence	Colour with: Hydrochloric acid	Wiesner's reagent
A	0	0	0	0	brown (*a*)	green-brown	dark lilac
B	streak	0·95	streak	streak	pink (*a*) mauve-opaque (*b*)	green-blue	transient green-blue
C	0·42	0·90	0·28	0·32	green (*b*)	nil	blue
D	0·57	0·88	0·19	0·67	blue-green (*b*)	nil	lilac
E	0·64	0·84	0·19	0·20	mauve (*b*)	nil	intense pink
F	0·72	0·79	—	—	nil	nil	pale pink
Vanillin	0·69	0·94	0·40	0·77			
Syring-aldehyde	0·64	0·90	0·13	—			

(*a*) In daylight; (*b*) in ultra-violet light; (*c*) organic phase.

10 per cent of the fraction. After a few days compound *C* became immobile in 6 per cent acetic acid and then turned green with hydrochloric acid. In order to minimize such changes, compounds *B*—*E* were separated on a number of washed No. 3 Whatman papers with 6 per cent acetic acid (or methanol–*iso*propyl–ether–water with compound *B*). As soon as the sheets had dried the bands were cut out, extracted with methanol and examined.

Compound *B* ($\lambda_{max.}$ (in ethanol) 225, 265 mμ; $\lambda_{max.}$ (in sodium ethoxide[5]) 248, 289 mμ) decolorized dilute potassium permanganate, and after alkali–nitrobenzene oxidation on a micro-scale yielded vanillin and *p*-hydroxy-benzaldehyde which were identified by comparison with authentic samples in several chromatographic solvents[3]. The green formed in klinki pine appears to be due to compound *B*, and is different from the paler green formed in spruce wood. Pew[6] considers that the blue component of the latter colour is the result of condensation between a substituted coniferyl aldehyde group and a phenylpropane group in the lignin. The absorption maxima of compound *B* in ethanol – 28 per cent hydrochloric acid at −5° C. were 500 and 640 mμ and are higher than those of compounds previously studied[6].

The absorption maxima of compounds *C*—*F* in ethanol were, respectively, 262, 354; 260, 333; 265, 322; 282, 324, 368 mμ. The maxima of compounds *C*—*E* in sodium ethoxide[5] were 268, 418; 260, 405; 250, 376 mμ, and in ethanol and tetramethyl ammonium hydroxide[1] were 225, 286, 422; 225, 285, 405; 225, 243, 290, 386 mμ, respectively. These results suggest that the compounds contain a substituted cinnamaldehyde grouping and a free hydroxyl[7]. This view was further supported by the decolorization of dilute potassium permanganate, reaction with dinitrophenylhydrazine, a strong reaction with phloroglucinol-hydrochloric acid (Wiesner's reagent) and formation of vanillin and *p*-hydroxybenzaldehyde during alkali-nitrobenzene oxidation (see above). It has been shown[8] that only those aromatic compounds containing an aldehyde group in conjunction with a double bond give a purple colour with Wiesner's reagent, but this is the first time a blue colour has been reported as with compound *C*. The absorption maxima of compounds *C*, *D* and *E* in phloroglucinol – 28 per cent hydrochloric acid[9] at 0° C. were 564, 548 and 537 mμ, respectively, and in resorcinol – 28 per cent hydrochloric acid[9] at 0° C. were 642, 580, 566 mμ.

The pink areas are frequently adjacent to decayed regions in klinki pine. The properties of the above compounds suggest that they are lignin degradation products and that they may be the products of microbiological action.

We are grateful to Mr. D. E. Bland for helpful discussions.

W. E. Hillis
Ann Carle

Division of Forest Products,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.
Sept. 16.

[1] Black, R. A., Rosen, A. A., and Adams, S. L., *J. Amer. Chem. Soc.*, **75**, 5344 (1953).
[2] Bland, D. E., *Aust. J. App. Sci.*, **6**, 511 (1955).
[3] Linstedt, G., *Acta Chem. Scand.*, **4**, 448 (1950).
[4] Goldschmid, O., *Tech. Assoc. Pulp and Paper Indust.*, **38**, 728 (1955).
[5] Nordström, C. G., and Swain, T., *J. Chem. Soc.*, 2764 (1953).
[6] Pew, J. C., *J. Amer. Chem. Soc.*, **74**, 2850, 5784 (1952).
[7] Aulin-Erdtman, G., *Svensk. Papperstid.*, **56**, 91 (1953).
[8] Adler, E., Björkvist, K. J., and Häggroth, S., *Acta Chem. Scand.*, **2**, 93 (1948).
[9] Pew, J. C., *J. Amer. Chem. Soc.*, **73**, 1678 (1951).

Potassium Uptake by Cation-Exchange Resins from Soils and Minerals

The use of cation-exchange resins for the extraction of soil potassium shows promise of being of value in soil fertility studies[1–4]. Wiklander[1] has discussed the factors which determine the equilibrium distribution of ions between two cation-exchange materials in contact with the same solution. However, the approach to the subject remains empirical because of lack of information on the activity of ions adsorbed on exchanger surfaces. The results with resins in Tables 1 and 2 were obtained by using sufficiently wide ratios of resin to soil or mineral to ensure that practically all the labile potassium was associated with the resin. The potassium analysis was done on the resins (> 60 mesh), which were isolated on a stainless steel sieve (60 mesh) by washing free from finely divided soil or mineral with a jet of distilled water. The washed resin was leached with *N* ammonium acetate and potassium determined in the leachate using an EEL flame-photometer. (Ammonium-exchangeable potassium is defined as that potassium in soil or mineral which is replaced by the ammonium ion during leaching with an excess of neutral *N* ammonium acetate.)

The results in Table 1 on the interaction of 'Amberlite' *IR*-120 resinates with soil slurries show that sodium-resin takes up approximately the amount of potassium that is ammonium exchangeable, while calcium-resin takes up less than the ammonium-exchangeable potassium. A fairly steady state between sodium- and calcium-resins and soil can be attained in 4 days. Considerably more than the

Table 1. THE UPTAKE OF POTASSIUM FROM SOILS BY SODIUM-, CALCIUM- AND HYDROGEN-RESINS COMPARED WITH THE AMMONIUM-EXCHANGEABLE POTASSIUM

Soil	Per cent total potassium in soil	Potassium release (per cent of total in soil)					
		'By leaching with *N* ammonium acetate	By intermittent shaking with 'Amberlite' *IR*-120 (1 gm. soil + 2 gm. resinate + 5 ml. water)				
			Sodium-resin	Calcium-resin	Hydrogen-resin		
			4 days	4 days	4 days	14 days	32 days
Saxmundham*							
Plot 4	1·18	1·31	1·27	0·51	1·86	2·37	2·54
Plot 5	1·28	2·19	2·11	1·09	3·12	4·06	4·37
Broadbalk†							
Plot 11	1·10	0·86	0·45	0·18	1·18	1·36	1·36
Plot 13	1·16	2·89	2·93	1·98	4·31	5·43	6·12

* For details, see ref. 5. † For details, see ref. 6.

ammonium-exchangeable potassium can be extracted from soil by hydrogen resin. Generally, but not always, the potassium extracted by hydrogen-resin can continue to increase over a month or more of intermittent shaking. Recent work has shown that soil from the long-term experiment at Saxmundham[5] (Suffolk) which has received no potassium fertilizer for 50 years (plot 4) releases significantly more of its non-exchangeable potassium to crops than does soil from the Broadbalk continuous wheat experiment at Rothamsted[6] (plot 11), which has received no potassium fertilizer for more than 100 years. The amounts of potassium extracted by hydrogen resins are in agreement with this finding. Comparing the potassium-treated soils, the Broadbalk soil (plot 13), which has received a higher rate of application for a longer period than the Saxmundham soil (plot 5), released the larger amount of potassium to hydrogen-resin.

Bremner[7] has shown that ammonium ions fixed in vermiculite can be quantitatively extracted by sodium- and hydrogen-resins. In view of the general similarity in the behaviour of inter-layer ammonium and potassium ions, the effects of resinates on some potassium-containing minerals were examined. The results summarized in Table 2 are not all of direct interest in soil studies but certain behaviour patterns are illustrated. It is only with biotite and potassium-saturated vermiculite that sodium- and calcium-resins extract considerably more than the ammonium-exchangeable potassium present in the minerals. Differences in the vigour of the attack by hydrogen-resin on the various minerals are interesting. Whereas the dioctahedral minerals release little of their non-exchangeable potassium to hydrogen-resin, the tri-octahedral minerals suffer considerable loss of potassium. Biotite is completely broken down by hydrogen-resin in about 10 days with the release of all its potassium. Phlogopite and lepidolite release considerable amounts of their potassium to hydrogen-resin in the course of a few days, but the attack progresses more slowly than with biotite. Such minerals as muscovite and 'hydrous mica', which are known to release their potassium to crops with difficulty, are comparatively resistant to hydrogen-resin attack.

Table 2. THE UPTAKE OF POTASSIUM FROM MINERALS BY SODIUM-CALCIUM- AND HYDROGEN-RESINS COMPARED WITH THE AMMONIUM-EXCHANGEABLE POTASSIUM

Mineral (through 100-mesh sieve)	Per cent potassium	Potassium release (per cent of total in mineral)				
		By leaching with *N* ammonium acetate	By intermittent shaking with 'Amberlite' *IR*-120 (0·2 gm. mineral + 2 gm. resinate + 5 ml. water)			
			Resinate	1 day	4 days	10 days
'Hydrous mica' (Fithian)	4·1	2·1	Na	2·6	2·9	2·8
			Ca	1·1	1·1	1·1
			H	5·0	5·4	5·5
Muscovite (Delamica)	7·1	1·4	Na	1·5	1·5	1·5
			Ca	1·3	1·3	1·3
			H	2·0	2·3	2·5
Glauconite (Brackles-ham)	6·5	3·1	Na	2·5	2·5	2·6
			Ca	1·9	2·2	2·1
			H	3·0	3·8	3·8
Biotite (flings)	6·75	5·3	Na	23·0	24·0	26·0
			Ca	11·0	11·0	11·0
			H	69·0	89·0	99·0
Phlogopite (flings)	6·8	6·6	Na	7·1	7·5	8·1
			Ca	5·1	5·6	5·5
			H	15·0	23·0	43·0
Lepidolite (flings)	6·95	5·6	Na	4·6	5·3	5·3
			Ca	3·6	3·7	4·0
			H	13·0	21·0	37·0
Vermiculite K-saturated	6·19	23·0	Na	49·0	50·0	49·0
			Ca	33·0	35·0	35·0
			H	71·0	75·0	75·0

The hydrogen-resin attack on minerals containing potassium is of a discriminating nature, capable of disclosing the presence of relatively accessible sources of potassium which are not immediately exchangeable. The existing evidence supports the view that hydrogen-resin data may prove to be of value in the assessment of the long-term ability of soils to supply potassium to crops.

P. W. ARNOLD

Chemistry Department,
Rothamsted Experimental Station,
Harpenden, Herts.
Sept. 19.

[1] Wiklander, L., *Ann. Agric. Coll. Sweden*, **16**, 670 (1949).
[2] Pratt, P. F., *Soil Sci.*, **72**, 107 (1951).
[3] Salomon, M., and Smith, J. B., *Soil Sci. Soc. Amer. Proc.*, **21**, 222 (1957).
[4] Hogg, D. E., *N.Z. J. Sci. Tech.*, **38**, A, 1015 (1957).
[5] Cooke, G. W., Mattingly, G. E. G., and Williams, R. J. B., *J. Soil Sci.*, **9**, 298 (1958).
[6] Chambers, W. E., *J. Agric. Sci.*, **43**, 473 (1953).
[7] Bremner, J. M., Rep. Rothamsted Exp. Stat., 57 (1957).

Aluminium Interlayers in Soil Clay Minerals, Montmorillonite and Vermiculite

IN the past few years, some workers[1–3] have described the presence in soils of a vermiculite-like clay mineral with a 14 A. basal reflexion, showing a behaviour intermediate between that of vermiculite and chlorite when subjected to the usual procedures for characterization of clay minerals. This was attributed to aluminium in interlayer positions. Tamura[4], of this laboratory, expanded this mineral by removing the interlayer aluminium with sodium citrate followed by saturation with calcium and solvation in glycerol. He thus showed the mont-

morillonitic nature of this mineral, which is widely distributed in the Holyoke and Wethersfield soils of the north-eastern United States. Considerable quantities of mineral with a stable 14 A. basal spacing occur in Hartford, Charlton and Gloucester soils in Connecticut. Interlayer aluminium may contribute to the low cation-exchange capacity, toxicity of aluminium and fixation of phosphate so commonly encountered in these soils.

After removal of free iron oxides[5] and interlayer aluminium[4] from the clay fractions of these three soils, the 14 A. component behaved like vermiculite. It gave a 14 A. basal spacing on saturation with magnesium and solvation in glycerol which collapsed to 10 A. on saturation with potassium. In contrast, before extraction of aluminium, the spacing did not collapse to 10 A. on saturation with potassium and drying at 100° C. Intensive treatment with sodium citrate for 12 hr. did not result in any further expansion of the 14 A. spacing, thus establishing the identity of this mineral as vermiculite with aluminium interlayers. Thus aluminium interlayers inhibit the expansion of montmorillonite from 14 A. to 18 A. and resist the contraction of both montmorillonite and vermiculite when saturated with potassium and dried at 100° C.

The formation of aluminium interlayers is essentially chloritization of the expanding type 2 : 1 layer silicates in soils. Therefore, the self-explanatory terms 'chloritized montmorillonite' and 'chloritized vermiculite' are proposed, and are used here for the two species which, after the removal of the aluminium interlayers, are characterized as montmorillonite and vermiculite.

Detailed study of the Charlton silt loam profile shows that the mineral component in the fresh and weathered parent rock (Bolton micaceous schist) with 14 A. spacing is a true vermiculite as shown by the contraction of its interlayer space to 10 A., after saturation with potassium. With the greater intensity of weathering near the surface, aluminium becomes more available, and the aluminium interlayers become increasingly stable. In the *A* horizon, 6–9 hr. of extraction with sodium citrate were required to give sharp 10 A. diffraction maxima after saturation with potassium and drying at 100° C., whereas in the B_2 horizon only 3 hr. of extraction effectively removed the interlayer aluminium. In the 14 A. component of the C_1 horizon, a shorter extraction period sufficed. As the weathering of primary minerals proceeds, aluminium becomes more available, and under the mild acid conditions prevailing in this brown podzolic soils region, it is precipitated in the interlayer spaces of the expanding type 2 : 1 layer silicates.

The end product, that is, chloritization, is the complete regradation of chlorite in soils. A continuous chloritized montmorillonite and chloritized vermiculite–chlorite series may exist. Chlorite formation in soil clays is analogous to the laboratory preparation of chlorite from montmorillonite[6].

In clays from some soils of California which are now saline, broad diffraction effects corresponding to spacings higher than 18 A. were observed with the usual glycerol solvation technique. On treating these soil clays with 2 per cent sodium hydroxide[7], diffraction maxima were resolved to 18 A. It was postulated that during some stage of weathering and formation of these montmorillonites, some cations might have been fixed in the interlamellar positions, thus effectively reducing the layer charge on these montmorillonites in this area, thereby resulting in the observed low-angle diffractions. Expansion of bentonite to 22 A. has been obtained (Sawhney, B. L., and Whittig, L. D., unpublished work) by hydrogen saturation followed by suspension in 1 *N* aluminium chloride solution of *p*H 2·7, washing and solvation in glycerol. Similarly, expansion of bentonite to even larger spacings has been achieved by I. Barshad (personal communication).

Thus aluminium may exist in different forms in the two cases : the aluminium interlayers in natural soil clays and the fixation of aluminium under the above experimental conditions. These forms certainly perform different functions in that aluminium interlayers in soil clays resist the expansion of montmorillonite spacings beyond 14 A., whereas aluminium saturation in the laboratory experiment resulted in the greater expansion of the mineral. It is suggested by Tamura[3] that the presence of $Al(OH)_2^+$ ions, and by C. I. Rich (personal communication) the presence of polymerized basic alumina in the interlayer spaces, are responsible for the non-collapse of the chloritized soil clay minerals. At the *p*H of the solution used by me, Al^{3+} or $Al(OH)^{2+}$ ions may be fixed on either side of the montmorillonite layer, thus reducing the overall net negative charge of the layer and consequently increasing the lattice expansion.

Attempts are being made to purify these aluminium-interlayered species from soil clays, and to introduce aluminium into the interlayer spaces of pure montmorillonite and vermiculite.

B. L. Sawhney

Department of Soils and Climatology,
Connecticut Agricultural Experiment Station,
New Haven, Connecticut.

[1] Rich, C. I., and Obenshain, S. S., *Soil Sci. Soc. Amer. Proc.*, **19**, 334 (1955).
[2] Brown, G., *Clay Minerals Bull.*, **2**, 54 (1953).
[3] Tamura, T., *Amer. Mineral.*, **42**, 107 (1957).
[4] Tamura, T., *J. Soil Sci.*, **9**, 1941 (1958).
[5] Aguilera, N. H., and Jackson, M. L., *Soil Sci. Soc. Amer. Proc.*, **17**, 359 (1953).
[6] Caillere, S., and Henin, S., *Mineral. Mag.*, **28**, 612 (1949).
[7] Foster, M. D., *Geochim. et Cosmochim. Acta*, **3**, 1943 (1953).

Ionospheric Measurements made at Halley Bay

Ionospheric measurements at the Royal Society Base at Halley Bay (75° 31′ S. 26° 36′ W. geomagnetic latitude 65° 47′ S.) started on April 1, 1957, and some results for the first year's operation are now available. The Base lies in the zone where the magnetic dip is abnormally small (65°) considering the high latitude and the general ionospheric variations are found to be remarkably regular.

Activity due to the incidence of corpuscular radiation, as shown by the occurrence of high absorption during the winter and equinoctial months, reaches a maximum near 0400 L.M.T. (30° W.) and more than two-thirds of the examples are found between 0100 L.M.T. and 1000 L.M.T. The incidence of high absorption is greatly increased at the equinoxes, as is usual for stations lying within a few hundred miles outside the zone of maximum auroral activity. It is remarkable that the auroral radio-echo index at Halley Bay, which mainly represents auroral activity at higher latitudes, shows a similar diurnal variation but shifted in phase towards the earlier hours. This is unexpected, as the corresponding phase-shift with

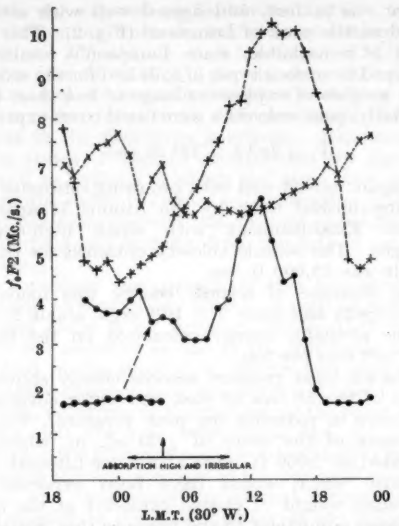


Fig. 1. Monthly median f_0F2 at Halley Bay. ●——●, July (winter); + - - - +, September (equinox); × - - - ×, December (summer)

increase of latitude in the northern hemisphere[1,2] is towards the later hours. The correlations between auroral and ionospheric phenomena appear to be very high, zenith aurora almost always giving high ionospheric absorption accompanied, sometimes, by weak reflexions from heights of about 75–80 km. A thick, group-retarding, auroral *E*-layer often accompanies auroral activity near the Base.

The detailed results returned to the United Kingdom for the first seven months of operation frequently indicate the presence of consistent recurrent diurnal changes in the *F*-layer, suggesting that the station is very favourably placed for studying the regular variations of this layer at high latitudes. The ionograms obtained near midnight in winter months show two distinct reflecting structures in the *F*-region: one which is sequentially continuous (Fig. 1) with the *F*-layer of the previous day, and the other, which usually first appears with the characteristic shape normally attributed to oblique reflexion from a tilted layer, develops into the *F*-layer of the subsequent day. Although vestigial reflexions from both structures are usually visible for about eight hours, the change-over from one structure giving the main trace on the ionogram to the other usually occurs in about an hour, near the time marked by the dashed arrow. It is normally complete before the start of the local corpuscular activity, as shown by auroral and blackout phenomena.

The main features of the diurnal variation of the *F*2-layer critical frequency, f_0F2, at Halley Bay are illustrated in Fig. 1. The following points are worth noting: (1) the large diurnal variation of electron density in winter, which is also evident in the total electron content of the layer, having a maximum near noon L.M.T. despite the absence of significant photo-ionization due to solar radiation; (2) the seasonal maxima of electron density in the day found at the equinoxes; these are similar to those found at Port Lockroy (65° S., 64° W.) and Port Stanley (52° S., 58° W.), though in the latter cases the diurnal maximum is reached before instead of after local noon; (3) the small diurnal variation in electron density in summer showing a maximum near midnight L.M.T.; this again is similar, apart from a phase shift, to that found at Port Lockroy; (4) the changes from summer type to winter type diurnal variations near the equinoxes are remarkably sudden, occupying only a few days.

These features suggest, of course, that the diurnal variations of the *F*2-layer near Halley Bay are mainly determined by movements of ionization and not by the recombination processes in the region.

We wish to acknowledge the contributions of Messrs. D. L. M. Cansfield and L. W. Barclay at Halley Bay.

This work was carried out as part of the programme of the Radio Research Board, and this communication is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

W. H. Bellchambers

Royal Society Base,
Halley Bay,
Antarctica.

W. R. Piggott

Radio Research Station,
Ditton Park,
Slough, Bucks.
Oct. 29.

[1] Cox, J. W., and Davies, K., *Canad. J. Phys.*, **32**, 743 (1954).
[2] Agy, V., *J. Geophys. Res.*, **59**, 499 (1954).

Observations on the Explosion at Ripple Rock

On April 5, 1958, one of the world's largest man-made non-nuclear explosions was fired at Ripple Rock in Seymour Narrows on the west coast of Canada. Briefly, the object of the explosion, which was carried out for the Department of Public Works, Canada, was to remove a twin peaked underwater rock from the centre of a narrow seaway. The method adopted was to sink a 500-ft. shaft on a nearby island and then drive a 2,400-ft. tunnel to points beneath the peaks. Further shafts each 300 ft. high were driven upwards into the rocks and an extensive system of short tunnels was excavated so as to honeycomb the peaks. These tunnels were filled with 1,400 tons of an explosive known as 'Nitramex 2*H*' manufactured by the Du Pont Company of Canada. The general arrangement is shown in Fig. 1.

A number of scientific parties observed the explosion and recorded the air blast, the seismic effects, the water waves and the effect on marine life. Among the teams was one from the Atomic Weapons Research Establishment, Foulness, which carried out close-in seismic and air blast measurements, and it is the purpose of this letter to communicate some of the results obtained.

Three types of seismic instruments were used. At the surface of the ground a velocity meter was used which consisted essentially of a mass–spring system in which the damping and natural frequency had been adjusted so that, over the anticipated range of predominant frequencies, the motion of the mass relative to the case was proportional to the velocity of the ground. Cambridge accelerometers were also employed for the surface measurements, these consisting simply of mass-spring systems with a natural frequency, in this case, of 20 c./s. and a damping factor of $\frac{1}{2}$ critical. At underground sites, within the

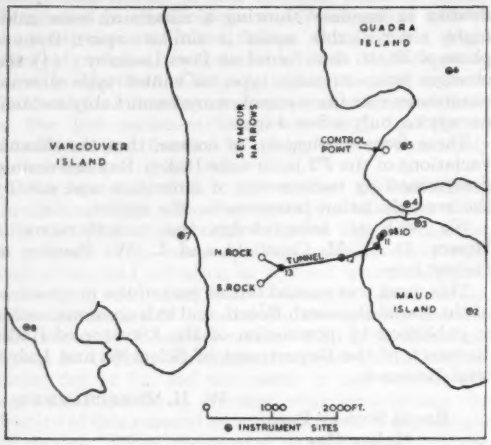


Fig. 1. Ripple Rock project

shaft and along the tunnel, variable-inductance accelerometers were employed. When subjected to acceleration the inductance of the gauges altered and modified the frequency of a local oscillator. The oscillator signals were fed to a central recording site at the top of the mine shaft where they were heterodyned and recorded on magnetic tape. Air blast measurements were obtained by means of mechanical gauges, where the deflexion of a diaphragm under the pressure loading was recorded on a moving film.

All the instrumentation was successful and good results were obtained. Peak accelerations in or out and up or down fitted to an expression of the form:

$$A = 3r^{-2.75} \times 10^8 \ g\text{'s}$$

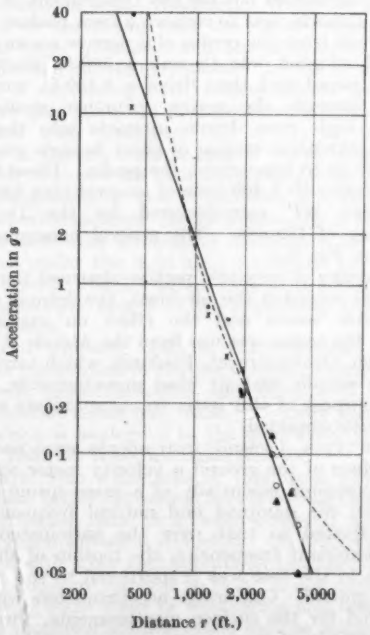


Fig. 2. Acceleration – distance curves. – – –, Prefiring estimate based on Lampson (ref. 1); ——, $3\ r^{-2.75} \times 10^8$; ×, out; ▲, in; ●, up; ○, down

where r is in feet, and agreed well with estimates based on the work of Lampson[1] (Fig. 2). This agreement is remarkable, since Lampson's results were obtained in various types of soils and for the most part with weights of explosive charge of less than 100 lb. Similarly, peak velocities were fitted to an expression:

$$V = 2r^{-1.2} \times 10^3 \text{ ft./sec.}$$

and again agreed well with pre-firing estimates based on unpublished work by the Atomic Weapons Research Establishment with small high-explosive charges. The seismic velocity obtained for the local basalt was 15,000 ft./sec.

An estimate of seismic energy was made from the records and gave 7×10^{16} ergs, about 2×10^{-3} of the available energy calculated on the basis of 4×10^{18} ergs per ton.

The air blast pressure records clearly showed the effect of the 50 feet of rock and water covering the explosive in reducing the peak pressure. The peak pressures of the order of $\frac{1}{4}$ lb./sq. in. which were recorded at 2,000 ft. were about one-fifteenth of the pressure which would have been expected from the same weight of charge exploded at the surface and were equivalent to the pressure that would have been recorded from only 0·6 tons of T.N.T. fired in this position. The records have a relatively sharp front, although not as sharp as the normal blast wave, but they also have a negative phase (pressure lower than atmospheric) which is much larger in amplitude than that normally encountered in explosive work. This pronounced negative phase will explain the marked Wilson cloud chamber effect which was visible on ciné records of the event.

To assist the long-range seismic measurements undertaken by the Dominion Observatory, Ottawa, an estimate of the time of firing was obtained from the times of arrival of the first seismic pulse in terms of observatory time broadcast for the event by the Canadian Broadcasting Corporation. The resulting firing time was 9.31.02·05 Pacific Standard Time with an estimated accuracy of ± 0·02 sec.

The assistance of the local contractors and constructors and many others is gratefully acknowledged. A great deal of the preliminary work was done by teams from the Suffield Experimental Station of the Defence Research Board of Canada, and to them, and in particular Mr. A. P. R. Lambert, field superintendent, we are deeply indebted. Thanks are also due to the Director of the Atomic Weapons Research Establishment, Aldermaston, and to the Canadian authorities for permission to publish this work.

J. K. Wright
E. W. Carpenter
A. G. Hunt
B. Downhill

Atomic Weapons Research Establishment,
Foulness,
Southend-on-Sea, Essex.

[1] Lampson, C. W., "The Effects of Atomic Weapons" (McGraw-Hill, 1950).

Presence of 6707 A. Radiation in the Twilight Sky

Since August 5, 1958, a patrol spectrograph at Hallett Station in Antarctica has frequently shown the presence of a strong emission line in the region of 6705 A. from the twilight sky. Following a report of this, a grating spectrograph at Invercargill, New

Zealand, was exposed on September 5, 1958, to the radiation coming from the twilight sky between the horizon and 20° altitude, on a bearing of 175° (true). A feeble line at 6707 ± 2 A. was detected on this occasion, and on several subsequent occasions. The use of a minus ultra-violet filter confirmed that the line was in the first-order spectrum. Exposures at varying states of twilight showed that the line was enhanced in twilight at about the same time as the well-known sodium *D*-line enhancement. Hallett station has also observed this twilight enhancement, both morning and evening, from the date of the first detection.

The measured wave-length of this line does not correspond to that of any atomic oxygen or nitrogen line[1], and there is no structure visible that would classify the emission as one of the molecular bands recognized in the spectra of auroræ and airglow[2,3]. The twilight enhancement in a manner similar to that of sodium, occurring at approximately the same time, suggests that the line arises from the $2^2S - 2^2P$ transition in the lithium atom (wave-length 6707·8 A.)[4]. This line is the first member of the principal series of lithium, and thus would be excited resonantly by solar radiation in the same manner as the D-lines of sodium. If this identification is accepted as correct, then the concentration and height of the lithium atoms may be estimated from a preliminary examination of the spectra.

The Invercargill plates show the emission line as a just detectable feature, not strong enough for microphotometry. Until the Hallett spectra are available for precise measurement, accurate estimates of the height and intensity of the lithium line are not, therefore, possible. However, in the middle of August, the lithium emission was observed at Hallett to be of about the same intensity as the total *D*-line emission, and a visual estimate of the density on the Invercargill plates suggests that, in September, the 6707 intensity was of the order of one-tenth the total intensity of the *D*-lines. The oscillator strengths of the lithium 6708 and of sodium 5890 + 5893 are similar[5], and a simple calculation shows that equal intensities of the lithium and sodium lines would result from a lithium concentration 5 per cent that of sodium. The calculation takes into account the Fraunhofer lines in the solar spectrum, and the Rayleigh scattering and ozone absorption in a model atmosphere used previously in colorimetric determinations of the twilight sky[6]. Nicolet[7] gives the total number of sodium atoms above 70 km. as 6×10^9 per cm.^{2}. This suggests that, in August, lithium was present in the upper atmosphere over Hallett to the extent of 3×10^8 atoms per cm.^{2}. The concentration to the south of New Zealand had apparently fallen to 3×10^7 atoms per cm.^{2} by early September. (These concentrations correspond to a total quantity of lithium in the upper atmosphere equal to 20 and 2 kgm. respectively, assuming a uniform distribution over the Earth's surface.)

Calculation of the effect of Rayleigh scattering and ozone absorption on the transmission of radiation through the model atmosphere shows that, after sunset at sea-level, 6708-A. radiation penetrates about 5 km. lower into the atmosphere than does 5893-A. radiation. Applying this correction to measurements of the altitudes above the horizon of the sodium and lithium enhancements observed at different stages of twilight at Hallett, Table 1 gives the estimates of the difference in height between the sodium and lithium layers.

Table 1

Date (1958)	Height of lithium – height of sodium (km.)
August 13	0
14	− 1
16	− 1
18	− 3
19	− 5
20	− 5
21	− 5
24	− 7
26	− 5
28	− 5
September 5	− 7

It seems likely that the height of the lithium layer has decreased, relative to the height of the sodium layer, by approximately 0·4 km. per day during the period covered by the observations.

The investigation, of which this is a preliminary report, is part of the research programme of the New Zealand Department of Scientific and Industrial Research. The high-dispersion spectrograph is on loan from the Air Force Cambridge Research Center, through Carter Observatory, Wellington, for the New Zealand International Geophysical Year auroral programme.

M. GADSDEN

D.P.L. Auroral Station,
Awarua Radio,
Invercargill,
New Zealand.

K. SALMON

Hallett Station,
Antarctica.
Sept. 23.

[1] Pearse, R. W. B., Proceedings of the Conference on Auroral Physics, 341 (U.S. Department of Commerce, Washington, 1954).
[2] Chamberlain, J. W., and Meinel, A. B., "The Earth as a Planet", 514 (Univ. of Chicago Press, 1954).
[3] Roach, F. E., N.B.S. Report No. 5006, 19 (National Bureau of Standards, Washington, 1956).
[4] "M.I.T. Wavelength Tables" (Wiley, New York, 1939).
[5] Filippov, A., and Prokofjew, W., *Z. Phys.*, **56**, 458 (1929).
[6] Gadsden, M., *J. Atmos. Terr. Phys.*, **10**, 177 (1957).
[7] Nicolet, M., Seventh Report of Commission for Solar-Terrestrial Relations, 165 (1951).

Behaviour of the Present Sunspot Cycle

IN a communication dealing with the behaviour of the present sunspot cycle, Visser[1] states that the changes in an unspecified ionospheric index are nearly independent of the simultaneous changes in the relative sunspot number, and, in particular, that the rapid increase in the sunspot number in 1957 was not accompanied by a corresponding increase in the ionospheric index.

Visser suggested that the reason for the lack of correlation between the two indices may be that ionospheric phenomena depend on the occurrence of solar eruptions, the incidence of which is not necessarily greatest when sunspots are most numerous. While the radiation emitted during solar eruptions is often known to influence the ionosphere, it is the relatively permanent background radiation which is the principal controlling factor. In view of this, it would be expected that ionospheric indices and sunspot numbers should behave in a broadly similar manner.

Tables have recently been prepared of the monthly mean values of two ionospheric indices, I_E and I_{F2}, which are based respectively on the degree of ionization in the *E* and *F*2 layers[2]. The unsmoothed values

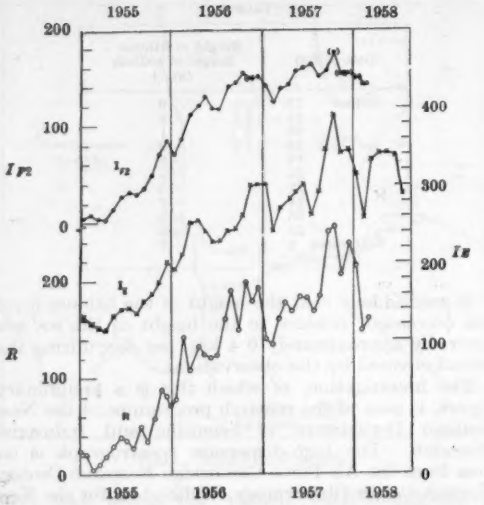


Fig. 1. The behaviour of the present sunspot cycle as indicated by the sunspot number and two ionospheric indices. ●—●—●, ionospheric index, I_{F2} [( ) doubtful value]; ×—×—×, ionospheric index, I_E; ○—○—○, rotational mean sunspot number R (after Visser)

of these indices are shown in Fig. 1 for the period January 1955 to date, together with the rotational mean values of the sunspot number taken from Visser's diagram. Both the ionospheric indices and the sunspot numbers vary in a very similar way, and even the smaller irregularities in the trend are sometimes visible in all three curves.

Visser also refers to the secondary oscillations in the sunspot number which occurred during the period 1947–50. These oscillations can also be clearly seen in even the unsmoothed values of the index I_{F2} for this period, and there is some evidence for their existence in the years following the 1938 peak in solar activity[3]. It is important to remember that, although ionospheric ionization is subject to large seasonal changes, there is no significant annual component in the indices I_E and I_{F2}. Hence, the fact that, at the epochs mentioned above, the oscillations in the ionospheric indices have a period of roughly one year cannot be attributed to a residual seasonal component in these indices.

The work described above was carried out as part of the programme of the Radio Research Board and is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

C. M. Minnis

Radio Research Station,
Ditton Park,
Slough, Bucks.

[1] Visser, S. W., *Nature*, **182**, 253 (1958).
[2] Minnis, C. M., and Bazzard, G. H., *J. Atmos. Terr. Phys.* (in the press).
[3] Minnis, C. M., *J. Atmos. Terr. Phys.*, **7**, 310 (1955).

Mr. C. M. Minnis's communication elucidates matters considerably.

The "unspecified ionospheric index" is that determined at De Bilt (daily sums of eight 3-hr. data).

At first I used the f_0F2 data of Slough and Washington[1,2], but since the data from De Bilt coincided fairly well with those of f_0F2 at Washington (ref. 2, Fig. 8) I therefore left the Slough and Washington data and took those of De Bilt, which were directly at my disposal. I must agree now that, for the present purpose, the simple I index of De Bilt does not suffice. As regards the secondary peaks, I find that their period certainly does not have a duration of about one year. I have now completed the investigation from 1863 to date. All sunspot cycles, Nos. 11–19, show the same character with considerable secondary peaks. A broad scattering from 6 to 19 synodic rotations being present, it is evident that there is no question of a regular period. Yet this feature of the sunspots may point to some interesting secondary solar action.

S. W. Visser

Friedhoff 4,
Ellecom,
The Netherlands.

[1] Visser, S. W., *Sci. Proc. Int. Assoc. Met.*, Tenth Gen. Assembly, Rome, 271, point 7 (1954).
[2] Visser, S. W., *Trans. Amer. Geophys. Union*, **39**, 835 (1958).

Maxwell Fish-eye treated by Maxwell Equations

The so-called Maxwell fish-eye[1] is a non-homogeneous lens the index of refraction of which varies according to the relation:

$$n(r) = \frac{2}{1 + (r/R)^2} \qquad (1)$$

where R denotes the radius of the sphere, and r the radial distance measured from the centre of the sphere. If a point source is located at the rim of the sphere the lens will focus the rays to another point on the rim at the opposite side. The lens was invented by James Clerk Maxwell in 1860 based upon the method of geometrical optics. It was the year before his enunciation of the electromagnetic theory of light.

In a previous communication[2] the problem of the Luneberg lens was treated rigorously as a boundary-value problem within the framework of the Maxwell equations. It was indicated therein that the same technique can be used to investigate the Maxwell fish-eye. The core of all such radially stratified problems is to resolve two differential equations of the form:

$$\frac{d^2S_n}{dr^2} + \left[k^2\varkappa(r) - \frac{n(n+1)}{r^2}\right]S_n = 0 \qquad (2)$$

and

$$\frac{d^2T_n}{dr^2} - \frac{d\varkappa(r)}{\varkappa(r)dr}\frac{dT_n}{dr} + \left[k^2\varkappa(r) - \frac{n(n+1)}{r^2}\right]T_n = 0 \quad (3)$$

where $k = \frac{2\pi}{\lambda}$ is the wave-number and $\varkappa(r) = n^2(r)$.

The constant n in these two equations is an integer. The two functions S_n and T_n are associated, respectively, with the transverse electric and the transverse magnetic modes in the analysis of the problem.

For the Maxwell fish-eye, if one substitutes equation (1) into equations (2) and (3) the resultant differential equations can be reduced to the hypergeometric equation by two transformations. Thus, if one denotes:

$$\rho = kr, \text{ and } \rho_0 = kR$$

then by changing the independent variable to ξ defined by:

$$\xi = -\rho^2/\rho_0^2$$

and let :

$$S_n = \xi^{n+1/2}(\xi - 1)^{\mu}U, \; T_n = \xi^{n+1/2}(\xi - 1)^{\mu-1}V$$

where :

$$\mu = \tfrac{1}{2}(1 + \sqrt{1 + 4\rho_0^2})$$

it can be shown that the functions U and V satisfy, respectively, the following two equations :

$$\xi(\xi - 1)U'' + [(2\mu + \beta)\xi - \beta]U' + \alpha U = 0 \quad (4)$$

and

$$\xi(\xi - 1)V'' + [(2\mu + \beta)\xi - \beta]V' + (\alpha - \tfrac{1}{2})V = 0 \quad (5)$$

where :

$$\beta = n + \tfrac{3}{2}, \text{ and } \alpha = \beta\mu + \rho_0^2$$

The prime denotes the derivative of the function with respect to ξ.

Equations (4) and (5) are identical, in form, to the hypergeometric equation :

$$\xi(\xi - 1)W'' + [(a + b + 1)\xi - c]W' + abW = 0 \quad (6)$$

By comparing equations (4) and (5) with (6) it is relatively simple to determine the constants a, b, and c in terms of α, β, and μ. For the analysis of the Maxwell fish-eye we only need the hypergeometric function $F(a,b,c,\xi)$, which is regular at $r = 0$.

So far as numerical work is concerned it is, of course, not an easy task. Until such results are available the detailed behaviour of the lens is not known. I wish merely to direct attention to the fact that the Maxwell fish-eye can formally be treated as a boundary-value problem, based upon the equations which Maxwell formulated.

CHEN TO TAI

Instituto Tecnológico de Aeronáutica,
São José dos Campos,
São Paulo,
Brazil.

[1] "The Scientific Papers of James Clerk Maxwell", 1, 285 (reprinted by Dover Publications, New York); see also Brown, J., "Microwave Lenses" (Methuen and Co., Ltd., London, 1953).
[2] Tai, C. T., *App. Sci. Res.*, B, 7, 113 (1958).

Separation of the Condensing Enzyme of *Aspergillus niger* from Acetyl Coenzyme *A* Deacylase and Citridesmolase and the Effect of Magnesium Ion on the Purified Fraction

THE condensing enzyme found in various tissues has been generally found to require magnesium for its activity. However, an exception was reported by Ramakrishnan and Martin[1], who found that the condensing enzyme of *Aspergillus niger* does not require magnesium and is, on the contrary, inhibited by it. Horecker and Mehler[2] suspected that the presence of citridesmolase as a contaminant might be responsible for this inhibition. Further, the presence of acetyl coenzyme *A* deacylase in cell-free extracts of *A. niger* has been recently detected in this laboratory and the enzyme purified[3]. It will be noted that this enzyme also needs magnesium for optimal activity and that the presence of this enzyme as a contaminant in the condensing enzyme is likely to cause its inhibition by magnesium. I have therefore reinvestigated the problem of the magnesium requirements of the condensing enzyme with reference to the presence of contaminants.

Calcium gel supernatant was prepared from cell-free extracts of *A. niger*, *N.R.C.* 233, according to the method of Ramakrishnan and Martin[4]. The preparation was tested for the condensing enzyme, acetyl coenzyme *A* deacylase and citridesmolase activities with and without magnesium ion. The assay system for these enzymes have already been described[2–5]. The results are given in Table 1.

Table 1. EFFECT OF MAGNESIUM ION ON CONDENSING ENZYME, ACETYL COENZYME *A* DEACYLASE AND CITRIDESMOLASE ACTIVITIES OF CALCIUM GEL SUPERNATANT FRACTION PREPARED FROM *A. niger*

Magnesium ion added	Magnesium ion content (μgm./ml.)	Specific activity of		
		Condensing enzyme	Acetyl coenzyme *A* deacylase	Citridesmolase
–	0·1	30·0	7·0	13·8
+	96·2	18·0	11·8	14·2

The contamination of the condensing enzyme preparation obtained by Ramakrishnan and Martin's method[4] with acetyl coenzyme *A* deacylase and citridesmolase is evident from Table 1. It also appears that magnesium ion inhibits the condensing enzyme and accelerates acetyl coenzyme *A* deacylase activity but does not have any effect on citridesmolase activity. Thus the inhibition by magnesium ion observed in the condensing enzyme preparation might have been due to the presence of acetyl coenzyme *A* deacylase.

The next step, therefore, was to remove these two contaminants from the condensing enzyme and study the effect of magnesium ion on the purified enzyme.

It was possible to obtain the condensing enzyme in a highly purified form as follows.

The methods of preparing cell-free extract of *A. niger*, *N.R.C.* 233 and ammonium sulphate fraction (40–60 per cent) have already been described[4]. The ammonium sulphate fraction was frozen overnight and thawed out and centrifuged. To the clear supernatant was added 0·5 volume of calcium phosphate gel, stirred for 15 min. at 0° C. and centrifuged at 6,000 r.p.m. for 20 min. To the supernatant was added 0·5 volume of alumina gel, stirred for 15 min. at 0° C. and centrifuged.

This procedure was found to yield a highly active condensing enzyme that appears to be completely free from acetyl coenzyme *A* deacylase.

The cell-free extract, the ammonium sulphate fraction, the calcium gel supernatant and the alumina gel supernatant were tested for the activity of the condensing enzyme as well as acetyl coenzyme *A* deacylase with and without magnesium ion.

Table 2. EFFECT OF MAGNESIUM ION ON CONDENSING ENZYME AND ACETYL COENZYME *A* DEACYLASE

Enzyme preparation	Mg++ added	Mg++ content (μgm./ml.)	Specific activity of :	
			Condensing enzyme	Acetyl coenzyme *A* deacylase
(1) Cell-free extract	–	0·2	0·63	1·6
	+	96·2	0·50	2·2
(2) Ammonium sulphate (40–60 per cent saturation) unfrozen	–	0·4	15·0	6·5
	+	96·6	10·5	9·1
(3) Ammonium sulphate fraction (40–60 per cent saturation) frozen and thawed	–	0·4	15·2	0·8
	+	96·6	10·6	1·1
(4) Calcium gel supernatant from 3	–	0·1	30·0	0·5
	+	96·1	18·0	0·7
(5) Alumina gel supernatant from 4	–	0·1	42·0	—
	+	96·1	5·1	—

It can be seen from Table 2 that the condensing enzyme in all the fractions is inhibited by magnesium ion whereas acetyl coenzyme *A* deacylase is activated. It will also be observed that the purified condensing enzyme is still found to be inhibited by magnesium ion. This suggests that the condensing enzyme of *A. niger* may be different from that obtained from other sources in respect of its magnesium requirement.

My thanks are due to Miss Mary Clements, Division of Applied Biology, National Research Council of Canada, for the gift of the strain of *A. niger*, *N.R.C.* 233, and lyophilized *E. coli*.

C. V. Ramakrishnan

Department of Biochemistry,
Baroda University,
Baroda. Sept. 9.

[1] Ramakrishnan, C. V., and Martin, S. M., *Nature*, **174**, 230 (1954).
[2] Horecker, B. L., and Mehler, A. H., "Ann. Rev. Biochem.", 256 (1955).
[3] Ramakrishnan, C. V., Raina, P. N., and Patel, N. T., *Arch. Biochem. Biophys.* (in the press).
[4] Ramakrishnan, C. V., and Martin, S. M., *Can. J. Biochem. and Phys.*, **32**, 434 (1954).
[5] Gillespie, D. C., and Gunsalus, I. C., *Bact. Proc.*, **80** (1953).

A Rapid Paper Chromatographic Procedure for the Quantitative Determination of Hydroxyproline

In a recent communication[1], we described a descending paper chromatographic procedure for the quantitative determination of hydroxyproline which required a solvent development of 40 hr. Using horizontal paper chromatography at an elevated temperature, comparable results have been obtained after development for only 4 hr.

Four standard hydroxyproline solutions (*p*H 6·5) containing, respectively, 0·050, 0·075, 0·100 and 0·125 μgm. of amino nitrogen are applied to the paper in 0·5 μl. volumes. The unknown solution is spotted (in 0·5 μl. volumes) to fall within the 0·50–0·125 μgm. range of the standard solutions.

Whatman No. 1 filter paper buffered[2] at *p*H 8·4 and measuring 12 cm. × 17 cm. is used. The origin is 2·5 cm. from one end. A 1·5-cm. tab, folded at right angles to the paper, is inserted into the solvent trough.

The chromatographic chamber and the manner in which the filter paper strip is supported in a horizontal position have been described[3,4].

The developing solvent is prepared at 22° C. in a temperature-controlled room by equilibrating equal volumes of redistilled *m*-cresol (Matheson Co., Inc., practical grade) and *p*H 8·4 buffer (0·067 *M*)[2]. The buffer solution must be within ± 0·1 *p*H to obtain the separation reported here. The solvent-rich phase is placed in the trough and the bottom of the chamber is covered with the buffer-rich phase. The covered chamber is housed in a mechanical convection oven at a temperature of 60° C.

After spotting, the filter paper strip is placed in the chamber and a solvent development of 4 hr. at 60° C. separates hydroxyproline from the other common amino-acids. Following solvent development, the chromatogram is dried for 1 hr. at 60° C. using a mechanical convection oven, dipped in a ninhydrin–isatin solution, and the colour of the hydroxyproline spots is developed by placing the chromatogram in an oven at 60° C. for 15 min. The colour reagent is composed of 270 mgm. of ninhydrin, 130 mgm. of isatin and 2 ml. of triethylamine made up to 100 ml. with water-saturated *n*-butanol. The merits of this hydroxyproline reagent have been discussed previously[5].

The maximum densities of the hydroxyproline spots are measured with a 'Densichron' transmission densitometer (Model 3835 *B*, W. M. Welch Scientific Co., Chicago) using a 1-mm. diameter aperture and no filter. A standard curve is prepared by plotting the logarithm of the known concentrations against the densities. The concentration of hydroxyproline in the unknown solution is then calculated by referring to the standard curve. The standard curves are not reproducible from one paper strip to another, and the standards must be run each time on the same chromatogram with the unknown.

Table 1. Accuracy and Precision of the Rapid Horizontal Paper Chromatographic Determination of Hydroxyproline

Chromatogram	Calculated concentration (mgm./100 ml.)
1	48·7
2	48·7
3	49·6
4	48·7
5	45·9
6	47·7
7	49·6
8	44·0
9	46·3
Average	47·7
Standard deviation	2·21
Deviation from theoretical value, 46·8 mgm./100 ml. (per cent)	1·9

The accuracy and precision of this rapid paper chromatographic procedure were established by determining the hydroxyproline content of a solution, *p*H 6·5, containing eighteen common amino-acids. The average value of nine chromatograms, 47·7 mgm./100 ml., differed from the theoretical value by 1·9 per cent (Table 1). The standard deviation was 2·21 mgm./100 ml. These values are in good agreement with an error of 0·9 per cent and a standard deviation of 1·41 mgm./100 ml. obtained when the solution was assayed using a descending paper chromatographic procedure[1]. The main advantage of the horizontal procedure is the shortening of the solvent development time from 40 hr. to 4 hr.

Henry R. Roberts
Michael G. Kolor
Wesley Bucek

Research and Development Division,
National Dairy Products Corporation,
Oakdale,
Long Island, New York.
Sept. 26.

[1] Roberts, H. R., and Kolor, M. G., *Nature*, **181**, 837 (1958).
[2] McFarren, E. F., *Anal. Chem.*, **23**, 168 (1951).
[3] Roberts, H. R., *Anal. Chem.*, **29**, 1443 (1957).
[4] Roberts, H. R., and Kolor, M. G., *Nature*, **180**, 384 (1957).
[5] Kolor, M. G., and Roberts, H. R., *Arch. Biochem. Biophys.*, **70**, 620 (1957).

Anæmia and Liver Damage in X-Irradiated Animals

A number of authors have found disturbances in various liver functions, damage to the liver in the form of fatty degeneration, and increase in the total liver fats in various mammals after total body irradiation with lethal doses of X-rays. According to Ellinger[1] these changes occur after irradiation with doses exceeding *LD*80, and the mechanism of their origin is not yet quite clear. Severe anæmia after irradiation, and resulting hypoxia of the liver and of other organs, might also occur. We have investigated this possibility, and have found that after total body irradiation with

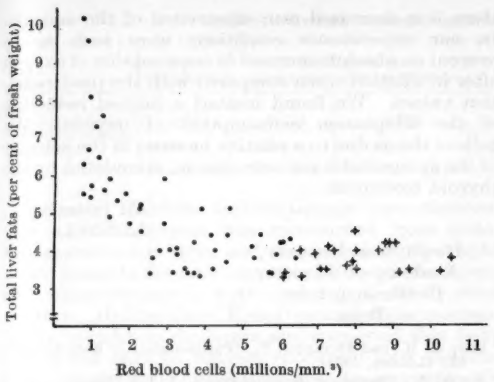


Fig. 1. Relation between the number of red blood cells and the amount of total liver fats in irradiated rats. +, Normal animals; ●, irradiated animals

high doses a striking relation exists between the decrease in red blood cell count and the amount of total liver fats.

Rats of the Wistar strain and white mice of the *H* strain, males and females, were subjected in several experiments to total body X-irradiation (180 kV., 15 m.amp.; 1 mm. aluminium, 0·5 mm. copper; dose-rate, 60 r./min.) with doses of 500–640 r. Food (Larsen diet) and water were given to the animals *ad libitum*. Between the eighth and the twelfth day the irradiated animals and the non-irradiated controls were killed by ether anæsthesia. Red cell counts were made on blood taken from the right heart chamber; in the liver samples, fats were repeatedly extracted with alcohol–ether (3 : 1) and re-extracted with chloroform. The fats were then determined by iodimetric titration after combustion in a solution of potassium dichromate and sulphuric acid[2]. In 22 normal rats the fresh liver tissue contained 3·77 ± 0·345 per cent total fats; for 33 mice the figure was 4·06 ± 0·544 per cent.

The results are summarized in Figs. 1 and 2. From Fig. 1 it is evident that in rats with a red blood cell count less than 2–2·5 million/mm.³, there is, as a rule, an increased amount of fats in the liver. Similarly,

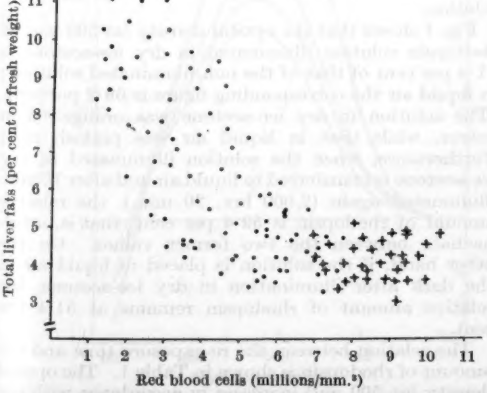


Fig. 2. Relation between the number of red blood cells and the amount of total liver fats in irradiated mice. +, Normal animals; ●, irradiated animals

for mice (Fig. 2) the liver fats increase when the red cell count drops to less than 4–5 million/mm.³.

We may therefore assume that until the critical figure is reached the organism is capable of compensating the deficiency of red blood cells and of hæmoglobin by various mechanisms, such as shifting the dissociation curves of oxyhæmoglobin to the right or increasing the pulse frequency and pulse volume; in severer anæmia the compensatory mechanisms are probably already insufficient. The difference between the critical values for rats and for mice might be related to the findings of Dowdy *et al.*[3], that mice are more sensitive to a decrease of oxygen pressure in the air than rats.

The relation between the drop in the red blood cell count and the rise in the amount of liver fats is not linear in either rats or mice. The partial rectification of the correlation curve of these two values for statistical evaluation is attained by using logarithms of both values. The correlation between the logarithms of the red cell count and the logarithms of the amount of liver fat in rats ($r = 0{\cdot}87$) is statistically highly significant ($t = 9{\cdot}3$; $P < 0{\cdot}0001$). Similar results are obtained for mice.

Clinically, it is known that severe anæmia and the consequent lack of oxygen in the organs causes, among other things, damage to the liver. After irradiation, however, this question has, so far as we know, not been investigated. The correlation is very striking, and certain facts in the literature (for example, that irradiated animals are less resistant to long exposure to reduced oxygen pressure[4]) lead us to assume that severe hypoxia of the tissue after irradiation is fatal to the organism.

Work on this problem is continuing.

M. Skalka

Department of Biophysics,
Czechoslovak Academy of Sciences,
Obráncu míru 10,
Brno.
Aug. 25.

[1] Ellinger, F., *Radiology*, **44**, 241 (1945).
[2] Kibrick, A. C., and Skupp, S. J., *Arch. Biochem. Biophys.*, **44**, 134 (1953).
[3] Dowdy, A. H., Bennett, L. R., and Chastain, S. M., *Radiology*, **55**, 879 (1950).
[4] Bytchkovskaja, I. B., Strelin, G. S., and Shiffer, I. V., *Med. Rad. (Moscow)*, **1**, No. 3, 85 (1956).

Effect of Thyroid Pre-treatment on the Mortality of X-Irradiated Mice

There is difference of opinion with respect to the changes of basal oxygen consumption in animals subjected to X-irradiation and to their significance. Some have observed increased metabolism after irradiation, whereas others have not been able to corroborate these results[1].

We have studied changes of metabolism during adaptation, as a means of ascertaining the activity of metabolic processes. Oxygen consumption is measured immediately after putting the animal into the chamber. As the animal adapts itself to the conditions of the measuring procedure, the changes in oxygen consumption are determined by the condition of the nervous system of the animals. Measuring adaptation consumption of oxygen gives results that are more easily reproducible than serial measurements of the 'basal metabolic' condition, which are more difficult[2,3]. During this work, we have found that animals for which general irradiation is fatal show a

reduction of the adaptation consumption of oxygen before their death (L. N., unpublished work). This reduction can be interpreted as failure of the capacity for adaptation of the nervous system, and it can be ameliorated by feeding the animals with thyroid prior to the irradiation. This favourable effect upon the adaptation metabolic capacity of the animals resulted also in higher survival of the irradiated mice.

White male mice of mean weight 30 gm. were fed in groups of 20 with dried thyroid (0·2 gm. gl. thyreoideae siccae per 100 gm. of food). After 20 days, this thyroid pre-treatment was stopped, and five days later the animals were irradiated simultaneously with a control series. They were subjected to this treatment in groups of six, the dose of whole-body X-irradiation being 600 r. (Super Sanax apparatus, 180 kV., 15 m.amp., 1 mm. aluminium, 0·5 mm. copper, target distance 43 cm., 60 r. per min.).

Group 1 (autumn 1957): mortality at 30 days for the control group ($n = 78$) was 71 per cent, while with the treated group ($n = 74$) it was 55 per cent, this difference being statistically significant ($P < 0·05$). Group 2 (spring 1958): mortality at 30 days for the control group ($n = 87$) was 91 per cent, whereas for the treated group ($n = 70$) it was 40 per cent, this difference being highly significant ($P < 0·01$).

The difference in death-rate in the two groups could be observed in the course of the second week, that is, during the period of maximum mortality. As to changes of weight, there was no difference between the experimental group and the control group immediately before irradiation and in the post-irradiation period. Prior to irradiation, as well as on the third and tenth days after irradiation, the adaptation consumption of oxygen was determined for groups of six mice. Fig. 1 gives the statistically significant difference in the average rates of the adaptation consumption of oxygen on the third and tenth days ($P < 0·005$) between the experimental group and the control group.

Such pre-treatment of mice with thyroid, therefore, reduces the post-irradiation mortality. Our results cannot be compared with the experiments of W. W. and F. Smith[4], owing to the different period of feeding which was used. The latter authors showed that when animals are fed with thyroid beginning a week before irradiation and continuing during irradiation, there is a decreased rate of survival of the animals. In our experiments conditions were such as to prevent an absolute increase in consumption of oxygen after irradiation when compared with the pre-irradiation values. We found instead a limited reduction of the adaptation consumption of oxygen. We believe this is due to a relative increase in the activity of the sympathetic nervous system, stimulated by the thyroid treatment.

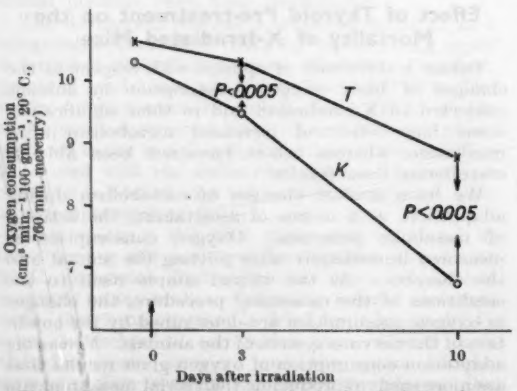


Fig. 1. Changes in oxygen consumption in the adaptation phase (*T*, experimental group; *K*, control group). Ordinates: values of oxygen consumption (cm.³ min.⁻¹ 100 gm.⁻¹, 20° C., 760 mm. mercury dry air). Abscissa: time of examination in days after irradiation

M. Pospíšil
L. Novák

Biophysical Institute,
Academy of Sciences,
10 Obránců míru,
Brno.

[1] Bacq, Z. M., and Alexander, P., "Fundamentals of Radiobiology", 229 (London, 1955).
[2] Novák, L., *Physiologia Bohemoslovenica*, **7**, 150 (1958).
[3] Pospíšil, M., and Novák, L., *Z. exp. Med.*, **129**, 385 (1957).
[4] Smith, W. W., and Smith, F., *Amer. J. Physiol.*, **165**, 639 (1951).

Chemistry of the Rhodopsin Cycle

In 1950, Wald, Durell and St. George[1] found a shift of the absorption maximum in a rhodopsin–glycerin mixture illuminated at − 73° C., and they proposed lumi-rhodopsin as the first intermediate in the rhodopsin cycle. They concluded that lumi-rhodopsin is stable at low temperature, and that when warmed to room temperature in the dark it is converted to a mixture of regenerated rhodopsin and retinene + opsin in roughly equal amounts. We believe[2], however, that the rhodopsin remaining unbleached after low-temperature illumination should not be regarded as having been regenerated from retinene and opsin, but could be recovered directly from lumi-rhodopsin. This communication is a further report of the recovery process.

Cattle rhodopsin solution was prepared as described in our previous paper[3]. After being kept in dry ice-acetone (− 78° C.) or liquid air (− 186° C.) for 5–6 min., rhodopsin solution was illuminated by a fluorescent lamp (2,000 lux, 20 min.), and then immediately raised to room temperature (23° C.) and left in the dark for 1 hr. The absorption spectrum was determined with a spectrophotometer before and after complete bleaching (8,000 lux, 20 min.). The difference spectrum thus obtained was regarded as a measure of the total amount of rhodopsin in the solution.

Fig. 1 shows that the optical density (at 500 mμ) of rhodopsin solution illuminated in dry ice-acetone is 51·4 per cent of that of the non-illuminated solution; in liquid air the corresponding figure is 69·2 per cent. (The solution in dry ice-acetone was orange-red in colour, while that in liquid air was pinkish red.) Furthermore, when the solution illuminated in dry ice-acetone is transferred to liquid air and after 10 min. illuminated again (2,000 lux, 20 min.), the relative amount of rhodopsin is 59·4 per cent, that is, intermediate between the two former values. On the other hand, if the solution is placed in liquid air in the dark after illumination in dry ice-acetone, the relative amount of rhodopsin remains at 51·4 per cent.

The relation between the re-exposure time and the amount of rhodopsin is shown in Table 1. The optical density (at 500 mμ) increases in accordance with the re-exposure time within 30 sec. and then tends to remain constant.

Table 1. Optical Densities (at 500 mμ) of Cattle Rhodopsin Solutions

	Non-illuminated	Illuminated in Liquid air	Illuminated in Dry ice-acetone	After illumination in dry ice-acetone, re-illuminated in liquid air for: 5 sec.	10 sec.	30 sec.	2 min.	10 min.	20 min.
Optical density	0·176	0·114	0·089	0·092	0·093	0·099	0·098	0·103	0·099
Total rhodopsin (per cent)	100	64·8	50·6	52·3	52·8	56·3	55·7	58·5	56·3

Recently, Hubbard and St. George[3] have observed that squid rhodopsin was regenerated from meta-rhodopsin in the light, and they consider that light would promote the interconversion between rhodopsin and meta-rhodopsin, both forming a steady-state mixture. Hubbard and Kropf[4] extended the mechanism to vertebrate rhodopsin and suggested that light is able not only to convert rhodopsin into all-trans lumi- or meta-rhodopsin but also to isomerize all-trans chromophores of lumi- or meta-rhodopsin to a steady-state mixture of stereoisomeric chromophores, all of which are still combined with opsin molecules. The neo-*b* and iso-*a* fraction of this mixture may correspond to rhodopsin and iso-rhodopsin respectively, so that the other isomers (labile fraction) must be regarded as responsible for 'lumi- or meta-rhodopsin'.

Though we carried out no experiments on the isomerization of chromophores, our experimental results suggest that a short-lived intermediate must be produced in any state before rhodopsin will be converted into 'dry ice-acetone illuminated rhodopsin' (lumi-rhodopsin[1]). We assume the existence of 'liquid-air illuminated rhodopsin' which can be clearly distinguished from 'dry ice-acetone illuminated rhodopsin', not only in colour but also in the relative amount of rhodopsin remaining after incubation at room temperature. It is worthy of note that the relative amount of rhodopsin increases when 'dry ice-acetone illuminated rhodopsin' is illuminated in liquid air. In other words, light acts on lumi- or meta-rhodopsin, making it return to 'liquid-air illuminated rhodopsin', that is, the intermediate which is considered to be stable at liquid-air temperatures. We shall call this phenomenon 'photo-recovery'.

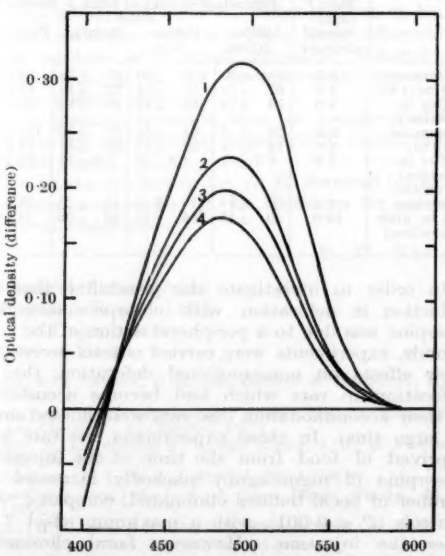
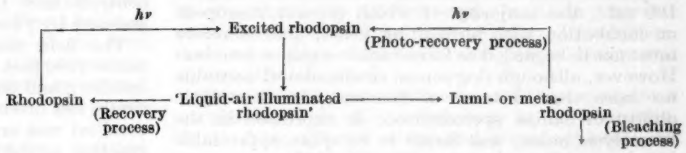


Fig. 1. Difference spectra of cattle rhodopsin solutions. 1, Non-illuminated; 2, illuminated in liquid air; 3, after illumination in dry ice-acetone, re-illuminated in liquid air; 4, illuminated in dry-ice acetone

Based on these considerations, we propose a scheme for initial changes in the rhodopsin cycle shown below. When lumi- or meta-rhodopsin absorbs light energy in liquid air, it changes into the excited state (photo-recovery) and then into 'liquid-air illuminated rhodopsin'.



The recovery process and the photo-recovery process may play important parts in rod vision. This will be the subject of our future investigations.

Tôru Yoshizawa
Yûji Kitô

Department of Biology,
Osaka University,
Japan.

[1] Wald, G., Durell, J., and St. George, R. C. C., *Science*, **111**, 179 (1950).
[2] Yoshizawa, T., and Kitô, Y., Ann. Rep. Sci. Works, Fac. Sci. Osaka Univ., 6, 27 (1958).
[3] Hubbard, R., and St. George, R. C. C., *J. Gen. Physiol.*, **41**, 501 (1958).
[4] Hubbard, R., and Kropf, A., *Proc. U.S. Nat. Acad. Sci.*, **44**, 130 (1958).

Biochemical Characteristics of Dog Semen

Early observations on canine spermatozoa by Leeuwenhoek[1], and Spallanzani[2], although mainly confined to microscopic studies of sperm morphology and motility, included also experiments on various factors affecting sperm activity, and a successful attempt to perform artificial insemination in the bitch. A perusal of the existing literature, however, concerning the chemical composition of dog semen shows that the present knowledge is still very incomplete[3,4]. Moreover, the early analyses of dog semen were carried out mainly with whole ejaculates, although, as already shown by Ivanov[5], dog semen is ejaculated in three fractions, the middle one containing the highest concentration of spermatozoa.

The present study was undertaken in an attempt to extend the information available. The findings are based on an examination of semen from three mixed-breed dogs, using the artificial vagina designed by Harrop[6]. Average figures are quoted in order for the first, second, and third fractions, and the figure for the total ejaculate is in brackets.

The electrolytes determined in dog semen included (m.equiv./l.):

Sodium	164, 149, 154	(133)
Potassium	5·5, 11·5, 7·3	(7·9)
Calcium	1·6, 0·9, 0·4	(0·5)
Magnesium	1·8, 0·8, 0·3	(0·5)
Chloride	154, 169, 160	(150)
Bicarbonate	2·2, 4·2, 2·3	(2·7)

Dog semen also contained (mgm./100 ml.):

Acid-soluble phosphorus	0·7, 29·3,	0·8	(7·4)
Copper	0·26, 1·26,	0·40	(0·51)
Zinc	2·20, 18·40,	7·63	(7·69)
Iron	0·03, 0·06,	0·02	(0·05)
Total reducing substances (expressed as hexose)	15·0, 17·0,	8·0	(20·5)
Fructose	0·47, 2·30,	0·34	(0·56)
Total protein	2,000, 7,000	1,500	(3,000)

It was found that the composition of semen, even if obtained from the same dog, was subject to considerable variation, in particular as regards the levels of sodium and chloride. It was also found that, with a few exceptions, the second, or sperm-rich fraction, appeared to contain the highest concentration of any one constituent.

A noteworthy characteristic of dog semen is the very low level of total reducing substances (20·5 mgm./100 ml.), the majority of which do not disappear on incubation with fermenting yeast, and therefore must not be regarded as fermentable sugar or fructose. However, although dog semen as ejaculated contains no more than a trace of fructose, the fructolytic ability of canine spermatozoa, as expressed in the fructolysis index, was found to be quite appreciable —1·2 mgm. fructose were utilized by 10^9 spermatozoa in 1 hr. at 37° C. Other metabolic studies included measurements of sperm respiration. The oxygen uptake (in the presence of air) was found to be 230 µl. per 10^9 spermatozoa in 1 hr. at 37° C. The dependence of the respiration of canine spermatozoa on the cytochrome system is strongly indicated by the results of spectroscopic analysis. The examination of a suspension of dog spermatozoa in glycerol at the temperature of liquid air revealed the presence of a complete cytochrome system, including the absorption bands of cytochromes *a*, *b*, and *c*.

D. J. Bartlett

Department of Veterinary Clinical Studies,
University of Cambridge.

Oct. 15.

[1] Leeuwenhoek, A. van, "The Collected Letters of Antoni van Leeuwenhoek", Letters Nos. 38(24), 39(25), 1678, and No. 84(45), 1685 (English translation, **2**, 325, 349, 363, 365; **5**, 143 (Sweets and Zeitlinger, Amsterdam, 1941)).

[2] Spallanzani, L., "Dissertations Relative to the Natural History of Animals and Vegetables" (English translation, **2**, 250 (Murray, London, 1789)).

[3] Huggins, C., Harvey Lecture, **42**, 148 (1947).

[4] Mann, T., "The Biochemistry of Semen" (Methuen, London, 1954)

[5] Ivanov, E., *C.R. Soc. Biol., Paris*, **80**, 230 (1917).

[6] Harrop, A. E., *Brit. Vet. J.*, **110**, 194 (1954).

Effect of Drugs on Emotional Behaviour in Rats

A number of workers have investigated, in experimental animals, the effects of tranquillizing drugs on learned behaviour motivated by fear. John *et al.*[1] have suggested that reserpine inhibits conditioned avoidance behaviour by interference with learned associations, whereas Weiskrantz[2] believes that reserpine reduces sensory perception. Miller[3] suggested that chlorpromazine reduces fear motivation and that this is independent of its sedative action or of an effect on motor co-ordination.

Since there have been few reports concerning the action of these drugs on unlearned behaviour, some results obtained on emotional behaviour are of interest.

Defecation has frequently been used as a measure of emotional behaviour in the rat and the validity of this measure has been recently reviewed by Broadhurst[4]. Furthermore, emotional defecation is correlated with the acquisition of a conditioned 'anxiety' response[5] and it has been found that chlorpromazine reduces this conditioned defecation[6].

Male rats, fed and watered *ad libitum*, were placed for the first time in an unfamiliar environment, an 'open field', consisting of a small arena 3 ft. 6 in. in diameter. The number of fæcal boluses excreted in 3 min. was used as the index of emotionality[4] or fear, while ambulation was recorded as a measure of sedation. Other types of behaviour such as preening, which may be a 'displacement reaction'[6], and rearing, which was correlated with ambulation, were also noted.

In each experiment the behaviour of treated rats (usually ten per dose) was compared with that of controls and the significance of the results was assessed by *t* tests.

The field was illuminated more brightly at the centre (700 foot candles) than at the periphery (30 foot candles), and this caused the rats to venture into the centre less often than when even illumination (30 foot candles) was employed. This may represent a fear reaction to the light[4].

Chlorpromazine produced a graded and parallel reduction in all types of behaviour (Table 1), but the treated rats did not venture into the centre of the field any more than did the control rats. Reserpine produced similar effects and both drugs caused obvious drowsiness. In contrast to these results, prochlorperazine reduced ambulation, rearing and preening, yet had no significant effect on defecation, and produced very little drowsiness in the doses used.

Table 1. Effect of Drugs on Emotional Behaviour in Rats

	Mgm./kgm. subcutaneously	Percentage of control value ± standard error			
		Ambulation	Defecation	Rearing	Preening
Chlorpromazine (1 hr. after injection)	0·5	78 ±30	100 ±20	67 ±16	89±25
	1·0	60 ±15	83 ±22	62 ±16	46±18
	2·0	38 ±13	49 ±15	37 ±14	32±18
Reserpine (18 hr. after injection)	0·5	59 ± 8	91 ±31	63 ±13	140±23
	1·0	16 ± 8	22 ±24	20 ±12	43±17
	2·0	0·7± 7	2·8±22	2·5±12	39±19
Prochlorperazine (1 hr. after injection)	2·5	52 ±13	73 ±25	48 ±22	78±26
	10·0	20 ±13	105 ±25	20 ±20	38±28

In order to investigate the possibility that the reduction in defecation with chlorpromazine and reserpine was due to a peripheral action of the compounds, experiments were carried out to investigate their effects on non-emotional defecation, that is, defecation in rats which had become accustomed to their accommodation (the rats were housed singly in large tins). In these experiments the rats were deprived of food from the time of the injections. Reserpine (2 mgm./kgm.) markedly increased the number of fæcal boluses eliminated, compared with controls ($P < 0.001$), with a maximum effect 2 hr. after the injection. However, fæcal elimination 6–23 hr. after injection was normal ($P > 0.3$). Chlorpromazine (20 mgm./kgm.) increased elimination from 5·6 ± 1·5 (standard error) fæcal boluses per rat (controls) to 9·7 ± 0·9 fæcal boluses per rat

(treated animals), throughout 17 hr. following injection. In another experiment 10 mgm./kgm. of chlorpromazine had no effect. When tested in the 'open field' on the second day of the experiment, that is, about 19 hr. after chlorpromazine and 25 hr. after reserpine, the treated rats defecated less ($P < 0.02$) than the controls.

These experiments show that both drugs increased non-emotional defecation. Therefore the reduction in emotional defecation is unlikely to be due to a peripheral constipating effect. Furthermore, the reduction in emotional defecation by reserpine was not due to a decrease in food consumption.

Several other centrally acting drugs have been tested in the 'open field' with the following results.

Benactyzine (4–16 mgm./kgm. subcutaneously) increased ambulation and reduced defecation but the latter effect may be due to a spasmolytic action[9]. Meprobamate, methylpentynol, and pentobarbitone modified behaviour only at doses which caused ataxia, the chief effect being an increase in ambulation. Dexamphetamine resembled lysergic acid diethylamide, the most interesting effect being a reduction in ambulation at the centre of the field with doses (5 and 0·5 mgm./kgm. subcutaneously respectively) having no significant effect on overall ambulation: this suggests potentiation of the stress response to the light.

Since chlorpromazine and reserpine reduced emotional behaviour only at doses which caused sedation, these results suggest that the principal behavioural effect of these drugs in experimental animals is one of sedation, while the reduction in fear-motivated behaviour observed in these experiments and in experiments involving conditioning techniques, is secondary to the sedation.

The results obtained with prochlorperazine support this view since the compound produced less drowsiness than did chlorpromazine in the doses used, and did not reduce defecation. Courvoisier *et al.*[10] also found that prochlorperazine was less active than chlorpromazine in various tests of 'sedation' yet it had a greater cataleptic action. This latter observation could explain why prochlorperazine reduced the motor reactions to the environmental stress, but not the visceral reaction.

It is possible, however, that the measures of fear adopted are insufficiently sensitive to detect effects at small doses.

My thanks are due to Dr. D. R. Maxwell for useful discussion and to Mr. R. B. Hutchins for valuable technical assistance.

R. W. Ryall

Research Laboratories,
May and Baker, Ltd.,
Dagenham,
Essex.

[1] John, E. R., Wenzel, B. M., and Tschirgi, R. D., *Science*, **127**, 25 (1958).
[2] Weiskrantz, L., in "Psychotropic Drugs", edit. by Garattini, S., and Ghetti, V., 67 (Elsevier, 1957).
[3] Miller, R. E., Murphy, J. V., and Mirsky, I. A., *J. Pharmacol.*, **120**, 379 (1957).
[4] Broadhurst, P. L., *Brit. J. Psychol.*, **48**, 1 (1957).
[5] Hunt, H. F., and Otis, L. S., *J. Comp. Physiol. Psychol.*, **46**, 378 (1953).
[6] Hunt, H. F., *Ann. N.Y. Acad. Sci.*, **65**, 258 (1956).
[7] Hall, C. S., *J. Comp. Psychol.*, **18**, 385 (1934).
[8] Jacobsen, E., in "Psychotropic Drugs", edit. by Garattini, S., and Ghetti, V., 119 (Elsevier, 1957).
[9] Larsen, V., *Acta Pharmacol. et Toxicol.*, **11**, 405 (1955).
[10] Courvoisier, S., Ducrot, R., Fournel, J., and Julou, L., *C.R. Soc. Biol.*, **151**, 1144 (1957).

Zinc Deficiency induced by Mercury in *Coffea arabica*

A zinc deficiency has been induced in *Coffea arabica* trees in Kenya Colony as a result of spraying with fungicidal formulations containing mercury in organic combination. The symptoms were first observed in October 1957 on coffee trees which had been treated with certain mercurial sprays against coffee berry disease (*Colletotrichum coffeanum* Noack).

The first effects were observed on trees in field trials which had been treated with phenyl mercury acetate, and appeared 4–5 months after the last application of the fungicide. These effects took the form of a severe leaf scorch such as is often associated with the use of phytotoxic materials. Later, other symptoms which affected the growth of the shoots and leaves were observed.

The internodes were abnormally short and some of the youngest leaf pairs were reduced in size, giving the end of the shoot a bunchy, rosetted, appearance. The leaves were often chlorosed in a manner typical of zinc deficiency in this crop, and, in extreme cases, were reduced to the mid-rib. In addition, there were other cases where one pair of leaves was abnormally elongated.

Since it was known that certain of these symptoms are characteristic of zinc deficiency in *Coffea arabica*, leaves from affected trees and from adjacent unsprayed and unaffected controls were analysed spectrographically for zinc content. The results of these preliminary analyses are given in Table 1.

Table 1

	Zinc content (p.p.m.)
Affected leaves (taken from trees which had received six applications of phenyl mercury acetate)	3·6
Control leaves (unsprayed)	14·0

Comparative analyses were afterwards made of first, second, third and fourth leaf-pair samples, counting from the apex of the shoot, collected from both sprayed and unsprayed trees. The figures obtained from these analyses are given in Table 2.

Table 2

	Leaves from sprayed shoots (p.p.m. zinc)	Leaves from unsprayed control (p.p.m. zinc)
First leaf pair	13	31
Second leaf pair	14	20
Third leaf pair	9	19
Fourth leaf pair	8	7

The phenyl mercury acetate sprays are, therefore, associated with a greatly reduced zinc content at the distal ends of the shoots.

The difference in the zinc content of both the controls and the sprayed material shown in Tables 1 and 2 above is attributed to the time of sampling. For the analyses shown in Table 1, material was collected towards the end of the dry season, whereas the material which yielded the results shown in Table 2 was collected eight weeks later, after a period of rain.

Formulations containing mercury in soluble form, such as phenyl mercury acetate, have been observed to cause more severe symptoms than, for example, the relatively insoluble phenyl-mercury-8-hydroxyquinoline.

It is also evident from observations in the field that shoots which are most exposed to the direct rays of the sun suffer more severely. Trees under shade trees show far less severe symptoms.

Similar symptom effects to those described above have been observed by one of us on *Coffea arabica* in the Kivu District of the Belgian Congo following

spraying with a formulation containing arsenic. It would thus appear that the effect is not confined to sprays containing mercury. The mechanism of this effect, together with other aspects of the phenomenon, are being studied.

K. R. Bock
Coffee Berry Disease Research Unit,
Department of Agriculture,
J. B. D. Robinson
Coffee Research Station,
Department of Agriculture,
G. T. Chamberlain
East African Agriculture and
Forestry Research Organisation,
Muguga, Kenya.

Labelling of Cells in Thoracic Duct Lymph of the Guinea Pig after Tritiated Thymidine

Since tritium gives precise localization in radioautographs[1], and in view of the fact that thymidine is generally believed to be specifically incorporated into deoxyribonucleic acid[2], tritiated thymidine has been employed in recent years to an increasing extent for the study of cellular proliferation.

The studies now reported have been conducted on a series of 22 male guinea pigs, of mixed strain, weighing approximately 400 gm. each. Tritiated thymidine with specific activity of either 0·36 or 1·9 curies/m*M*. was given in doses of 1 μc. per gm. body-weight, and thoracic duct lymph and blood were studied in smear preparations at various periods afterwards. Suspensions and sections were also prepared of thymus, cervical and mesenteric lymph nodes, spleen and bone marrow. Coated radioautographs were prepared by the method of Belanger and Leblond[3].

Labelled lymphocytes began to appear in lymph during the first hour after the administration of tritiated thymidine, and were thereafter present for several days. To begin with, labelled large lymphocytes are mainly in evidence, though some medium lymphocytes are also seen. Gradually, the size distribution of the labelled cells changes, so that in one experiment the size distribution during the first hour was 47 : 7 : 0 (that is, 47 large, 7 medium and 0 small lymphocytes), in the second hour 48 : 20 : 0, in the third hour 57 : 35 : 4 and in the fourth 75 : 64 : 20. Labelled small lymphocytes began to appear during the third hour and then gradually increased. In the lymph of another animal, obtained at 14 hr. after thymidine, the size distribution among the labelled cells was 47 : 75 : 54, and in lymph collected after 25 hr. it was 33 : 65 : 94. After a single injection of thymidine, a steady stream of labelled lymphocytes, ranging from 2·0 to 7·0 per cent of the total thoracic duct cells, enters the blood over several days. These findings, which differ from those of Gowans[4] in the rat, suggest the continuous liberation of cells from a precursor pool. Labelled small lymphocytes were also found in the blood by the seventh hour, and in view of the work of Bond *et al.*[5], are presumably cells which have entered the blood after labelling in the lymphoid tissues.

Examination of the lymphoid tissues shows active synthesis of deoxyribonucleic acid from the outset, especially in the germinal centres. Though accurate quantitation is not yet possible, it seems clear that there is extensive new formation of lymphocytes; and that a large number of the small lymphocytes in thoracic duct lymph must be newly formed cells. The results do not support the concept either of massive re-utilization[6] or large-scale recirculation[7].

This work was supported in part by funds allocated to N. B. Everett through an institutional research grant from the American Cancer Society to the University of Washington, and by a U.S. Public Health Services research grant (W. O. Reinhardt).

J. M. Yoffey
Department of Anatomy,
The University, Bristol 8.
N. B. Everett
Department of Anatomy,
University of Washington School of Medicine,
Seattle 5, Washington.
W. O. Reinhardt
Department of Anatomy,
University of California Medical School,
Berkeley 4, California.

[1] Fitzgerald, P. J., Eidinoff, M. L., Knoll, J. E., and Simmel, E. B., *Science*, **114**, 494 (1951).
[2] Reichard, P., and Estborn, B., *J. Biol. Chem.*, **188**, 939 (1951).
[3] Belanger, L. F., and Leblond, C. P., *Endocrinol.*, **39**, 8 (1946).
[4] Gowans, L. J., Proc. Physiol. Soc., July 11–12 (1958).
[5] Bond, V. P., Cronkite, E. P., Fliedner, T. M., and Schork, P., *Science*, **128**, 202 (1958).
[6] Hamilton, L. D., in "The Leukemias" edited by Rebuck, J. W., Bethel, F. H., and Monto, R. W., 381–400 (Academic Press Inc., New York, 1957).
[7] Sjövall, H., "Experimentelle Untersuchungen über das Blut und die blutbildenen Organe—besonders das Lymphatische Gewebe—des Kaninchens bei wiederholten Aderlässen" (Hakon Ohlssons Boktryckeri, Lund, 1936).

Some Structural Characteristics of Myelinated Nerve Fibres

In a previous communication[1] observations were made concerning some errors attendant on methods which have been used in the quantitative examination of myelinated nerve fibres.

A technique demonstrated[2] to the Anatomical Society of Great Britain and Ireland on February 28 has been used to investigate the size relation of the axon and its myelin sheath[3]. During examination of the sural nerve and the nerve to the medial head of the gastrocnemius muscle of the rabbit some points of general interest not previously published have emerged.

5-μ transverse sections of fresh nerve were examined using a polarizing microscope, and measurements of axonal and external diameter made.

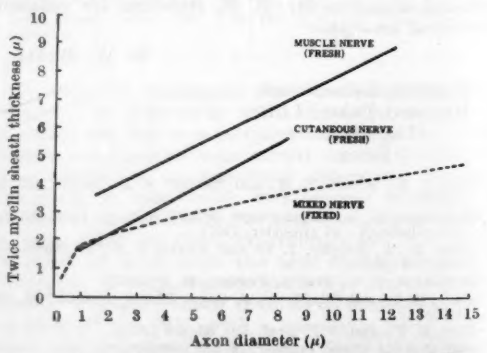


Fig. 1. Composite graph of twice myelin sheath thickness against axon diameter for a muscle nerve and a cutaneous nerve of the rabbit. A line derived from Sanders (ref. 4) for fixed and stained fibres of the mixed peroneal nerve of the rabbit is included for comparison

The lines representing fresh muscle and cutaneous nerves (Fig. 1) are calculated regression lines which have been tested for goodness of fit. The standard error of estimate of sheath thickness from axon diameter is 0·49μ and 0·57μ for the gastrocnemius muscle nerve and the sural nerve respectively. Full results, scatter diagrams and a statistical analysis will be published elsewhere.

It can be concluded that within the range of fibres studied: (1) in both muscle and cutaneous nerves a linear relationship exists between myelin sheath thickness and axon diameter; (2) the ratio of axon diameter to sheath thickness differs in cutaneous and muscle nerves; (3) the similarity in slope demonstrates that a unit increase in axon diameter is accompanied by an increment of sheath thickness which is similar for muscle and cutaneous nerves; (4) differences in slope and position of the line derived from Sanders[4] may be interpreted as resulting from admixture of muscle and cutaneous fibres in the peroneal nerve and the differential shrinkage inherent in processing.

The observed differences between muscle and cutaneous nerves make it desirable to investigate the effects of processing on each type of nerve separately. Such experiments are in progress.

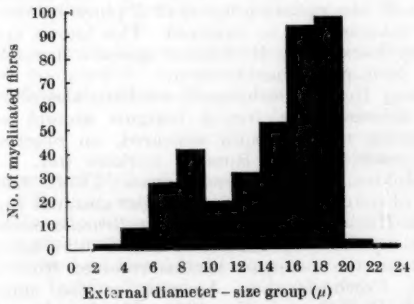


Fig. 2. External diameter-size frequency distribution of nervus gastrocnemius medialis of rabbit, exhibiting bimodality

A histogram (Fig. 2) illustrating the external diameter – size frequency distribution of the nervus gastrocnemius medialis of the rabbit prepared from a 5μ, fresh, transverse section, exhibits the typical bimodal form which has been demonstrated for fixed and stained preparations[5]. If, however, a histogram illustrating the internal diameter – size frequency distribution is constructed in a similar manner a unimodal form results (Fig. 3).

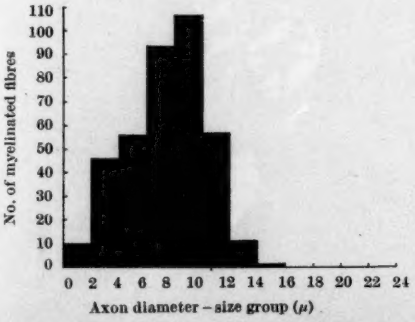


Fig. 3. Internal diameter – size frequency distribution of nervus gastrocnemius medialis of rabbit, exhibiting unimodality

In conclusion we wish to stress the following points: (1) histological techniques in current use should be subject to more critical evaluation; (2) our present results should be considered in investigations into impulse conduction, and the processes of growth and regeneration; (3) for many purposes simple external diameter measurements are inadequate; (4) for a more comprehensive study one should consider the interrelation between external diameter, internal diameter, internodal distance, and features of the nodal apparatus for a specific fibre population.

This work has been supported by a grant from the Central Research Fund, University of London.

C. P. Wendell-Smith
P. L. Williams

Department of Anatomy,
Guy's Hospital Medical School,
London, S.E.1.
Sept. 29.

[1] Williams, P. L., and Wendell-Smith, C. P., *Nature*, **181**, 125 (1958).
[2] Williams, P. L., *J. Anat.*, **92**, 650 (1958).
[3] Williams, P. L., and Wendell-Smith, C. P., *J. Anat.*, **92**, 651 (1958).
[4] Sanders, F. K., *Proc. Roy. Soc.*, B, **135**, 323 (1948).
[5] Quilliam, T. A., *J. Anat.*, **90**, 172 (1956).

Giant Nerve Cells and Fibres in *Arenicola claparedii* (Polychæta)

Our knowledge of the giant nerve cells and fibres of the Arenicolidae still rests on the pioneer work of Gamble and Ashworth[1]. These authorities described the structure and arrangement of the giant cell system in considerable detail and stated that they found it in all the species with one exception: "In *A. claparedii* there is, curiously enough, no trace either of giant cells or of giant fibres". They gave no details of the observations on which the statement just quoted was based, and no figures of the minute anatomy of the nerve cord in *A. claparedii*.

The conclusions of Gamble and Ashworth were accepted by later writers[2]. However, I recently decided to check the absence of giant nerve cells and fibres in *A. claparedii* because of the lack of detail on this point in their publication. It is, of course, well known that giant nerve cells and fibres are structures of great functional importance, and as all the tailed lugworms appear to live in much the same way, their absence in one only of the species would indeed be remarkable if it were true.

My observations were made on Neapolitan material. Transverse and sagittal serial sections were cut. They show giant fibres and giant cells arranged in the manner usual in the Arenicolidae, except only in one respect mentioned below. The structures approach those of other species in size. The cell in the accompanying photograph of a sagittal section has a cell body measuring 0·038 mm. by 0·029 mm. and a nucleus 0·013 mm. in diameter. In *Arenicola marina*, according to Gamble and Ashworth[1], "The cells measured 0·04 mm. in length and about 0·02 mm. in breadth".

The peculiarity of *A. claparedii* is that its giant cells lie in an unusually lateral position, as shown in the transverse section shown in Fig. 1. In other species, they occupy a nearly mid-ventral position within the cord. This may be correlated with a difference in the position of the cord as a whole, which lies deep to the circular muscle layer in most species, but outside that layer and in close contact with the epidermis in *A. claparedii*. If it may be sup-

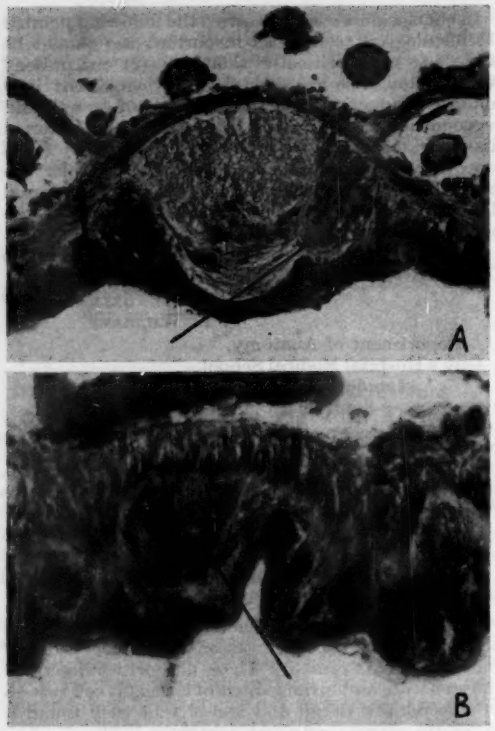


Fig. 1. *A*, transverse section through the nerve cord and surrounding tissues of *Arenicola claparedii*, showing two giant fibres (median, at the upper surface of the cord) and a giant cell (indicator line). *B*, sagittal section to show a giant cell. In each picture the length of the indicator line corresponds to 0·1 mm.

posed that Gamble and Ashworth sought the giant cells in sagittal sections cut through the main, fibrous part of the cord—a method that succeeds with any other species—their failure to detect the cells in *A. claparedii* can be explained; for sagittal sections must be cut to one side of the main mass of the cord if they are to pass through the giant cells in that species.

G. P. Wells

Department of Zoology,
University College,
London, W.C.1.
Oct. 22.

[1] Gamble, F. W., and Ashworth, J. H., *Quart. J. Micr. Sci.*, **43**, 419 (1900).

[2] Ashworth, J. H., "Catalogue of the Chaetopoda in the British Museum: *A.* Polychaeta. Part 1. Arenicolidae" (London, 1912). Nicol, J. A. C., *Quart. Rev. Biol.*, **23**, 291 (1948). Wells, G. P., *J. Mar. Biol. Assoc. U.K.*, **29**, 1 (1950).

Anti-brucella Phage

Anti-brucella phage was discovered by the Russian workers Drozewkina[1] and Viershilova (private communication; 1956) who isolated it from manure and old cultures of *Brucella*. They demonstrated an influence of the phage on the dissociation of *Brucella* and suggested that mutation in *Brucella* was due to the action of the phage.

We have isolated fourteen brucella phages from our own collection of 200 strains of *Brucella* and compared them with the Russian phage with regard to (*a*) morphology, (*b*) influence on dissociation of *Brucella* and (*c*) their effect upon different types of *Brucella*.

Anti-brucella phage was searched for in old cultures of *Brucella brucei* in the following way. Small pieces of agar with the old brucella culture were added to new 6-hr. cultures of *Brucella brucei S*19 on Huddleson's liver medium. After 48 hr. in a thermostat and 24 hr. in a refrigerator, we removed a few drops of material and added them to new 6-hr. cultures of *Brucella brucei S*19.

This procedure was repeated ten times. Next, this material was filtered and treated with chloroform. It was then tested for phage on the standard strains of *Brucella* (*bovis*, *melitensis* and *suis*) on Braun's medium. In this way, we obtained phages, which were examined in the usual way for lytic titre.

Preparations for electron microscopy were obtained by centrifuging the cultures for 1 hr. at 18,000 r.p.m. They were shadowed with chromium.

Using the electron microscope (giving a magnification of 16,000) the phage appeared as a round elementary body, 60–80 mμ in diameter but with no tail. *Brucella* cells showed characteristic features of phage lysis (Fig. 1).

When phage begins to act on *S Brucella* colonies, a picture is obtained giving evidence of a process of dissociation into *R* and *I* forms. Using Braun's method[2], the radiating layers of *R* phase on the base of *S* colonies may be observed. This known type of colony described by Huddleson[3] appears, therefore, to arise from phage modification.

Using Henry's technique[4], we have also observed flat colonies with frayed margins around which numerous micro-colonies appeared, an observation also made by the Russian workers (ref. 1 and Viershilova, private communication; 1956). Another type of colony observed was the flat granular type.

The Russian phage did not lyse *Brucella melitensis* or *Br. suis* from our collection, neither did it have any effect on the *suis*-type strains received from Denmark, Czechoslovakia, America or the standard F.A.O. W.H.O. *suis* No. 1330. The Russian phage lysed typical *Br. abortus* strains (Fig. 2), but no lysis

Fig. 1. *Brucella brucei* and phage. (× 16,000)

Fig. 2. *Brucella brucei* (*bovis* 544) and fourteen races of phage (−) → (+++)

occurred when atypical strains (for example, strains differing from the standard F.A.O. W.H.O. strain 544) were exposed to the action of the same phage. However, it was observed that the specific action of the phage on *Br. abortus* changed; this involved both the phages and the *Brucella* strains. The fourteen phages isolated by us did not lyse either *melitensis* or *suis* strains. Further investigations are in progress.

Work is proceeding on the phage typing of *Brucella* strains comparable to the phage typing of the salmonellas, shigellas and staphylococci.

Józef Parnas
A. Feltynowski
W. Bulikowski

Department of Medical Microbiology
of Medical Academy and
Anthropozoonoses Section of
State Institute of Rural Occupation,
Medicine and Rural Hygiene,
Lublin, Poland.

[1] Drozewkina, *Trrdy Rostowskowo Inst. Mikrobiol.*, **10**, 260 (1956).
[2] Braun, W., *J. Bact.*, **52**, 7, 243 (1946).
[3] Huddleson, I. F., "Brucellosis in Man and Animals" (The Commonwealth Fund, New York, 1943).
[4] Henry, B. S., *J. Infect. Dis.*, **52**, 374 (1933).

An Electron-Microscopic Study of the Ciliature of the Trochophore Larva

The trochophore larvæ of marine polychæte worms present several ciliary structures convenient for comparative study.

From an electron microscopic study of the equatorial band (prototroch), which has a motor function, the following conclusions were drawn (figures in parenthesis refer to Figs. 1 and 2).

The structure of the external stem of the cilium as a ring of nine peripheral fibrils around a central fibril was confirmed (1).

At certain places the ciliary membrane, less dense and much thinner than the fibrils, encloses intraciliar swellings (2), apparently of ordinary cytoplasm. This ciliary membrane is continuous with the cellular one (3).

Before penetrating the cell, the cilia pass through pores in the cuticle, which consists of two layers (5 and 7) connected at several places (6). Between the cuticle and the outer cell membrane there is a large extracellular space (4) in which the cilia are

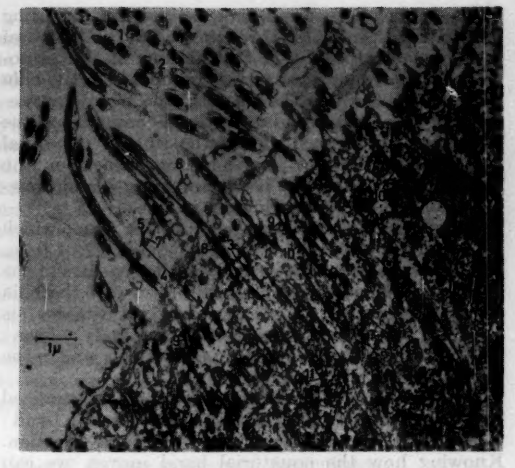


Fig. 1. Equatorial band of Trochophora (× 7,500). (1) Kinocilium, transverse section; (2) intracilar swelling; (3) cellular membrane; (4) extra-cellular space; (5) external layer of the exoplate; (6) connexion; (7) internal layer; (8) basal body; (9) basal body; (10) rootlet; (11) mitochondria

connected with the segments arising from the basal bodies (8).

The basal bodies (9) are nearly symmetrical, hollow and somewhat swollen in the centre. The rootlet (10) seems to sprout from the basal bodies and has a periodic structure, with an interval of about 600 A. Numerous mitochondria (11) are found close to the rootlets, which become narrower toward the end.

A narrow slit occurs between the top of the basal body and the ring (above 8) in which the nine fibrils of the stem end. The central fibril stops above this ring. Another ring, with nine external bristles, looking like a cog-wheel, is formed by the nine fibrils while crossing the external structure described above. The name 'exoplate' is suggested for this external formation, which envelops the whole trochophore like a bag, stretched around the cilia, folded elsewhere. This bag finishes in the stomodæum, where it is replaced by microvilli, standing like a palisade between the bases of the endodermic cilia.

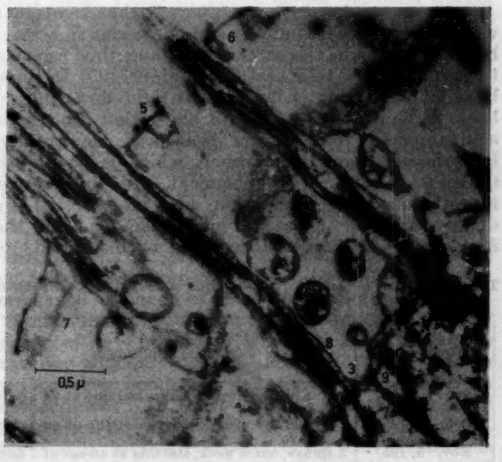


Fig. 2. Kino-cilia (part of Fig. 1) (× 30,000)

The trochophore larva shows a non-stop whirling motion in a spiral path through the fluid. The basal bodies, closely packed in the mid-line of the prototroch, form a semi-rigid structure, on which the cilia beat rhythmically. The beats result from contractions of the rootlets; during these contractions the outer part of the cell, under the ring of the basal bodies, is shortened. This compression acts on the hollow tube of the basal body, unfolding it and drawing the stem into a pendular motion.

The nine columns give rigidity to the stem, which can attain a length of 100μ for a diameter of 0·3μ. The exoplate ensures regularity in the spacings of the stems; its elasticity ensures the return of the cilia after movement. Hydrodynamic adjustment is made by continuous variation of the body's form: the looseness of the exoplate permits this under the control of the ciliary bands.

In slowing down, the whirling motion is neutralized by lateral bands of cilia, near the main moving band: in each cell the rootlets point in the same direction. Knowing how the equatorial band moves, we can deduce its function through the position of the cilia on the electron-micrographs, each cell being a functional unit.

A sagittal section of the main equatorial band (prototroch) reveals five different parts: the first and second decide the form of the animal; the third and fifth can, by fanning out, open and shut off the operating space of the fourth band, which forms the main motive organ.

A similar arrangement appears in the perianal band (telotroch), with a pars motoria working as a screw, and a pars plastica, over less compact cytoplasm, changing the form of the animal.

If we consider that the larva has to maintain a constant rhythm, each cell being sensitive to this pattern, the structures studied above explain how it is regulated. The role of the nerve is to give the tempo by a continuous wave of activation.

H. Seuntjens
W. G. Braams

Department of Oto-Rhino-Laryngology,
Boerhaave Hospital,
University of Leyden.

Gibberellic Acid and Vernalization

Several workers[1,2] have reported that treatment with gibberellic acid induces early flowering in certain biennial plants in the same season and thus replaces their normal low-temperature requirement. In these biennial plants, extension growth and flowering go hand in hand, and it is quite likely that gibberellic acid replaces vernalization treatment incidentally, by bringing about the former, which is an almost universal action of the chemical. In the present investigation this suggestion has been tested by determining the effect of gibberellic acid on the flowering of both vernalized and normal plants of *Brassica campestris* L., *Cicer arietinum* L., *Linum usitatissimum* L. and *Lens esculanta* Moench, none of which has any obligatory low-temperature need for flowering. In *Brassica*, the reproductive process is associated with a change in the growth habit of the plant from that of rosette formation to stem elongation, while in the rest it is not so.

Treatments consisted of: (1) post- and pre-vernalization soaking and soaking of normal seeds for 8 hr. at the room temperature and (2) one or several sprayings to run-off, and dropping on the youngest leaf at the apex, at different stages of growth, of both vernalized and normal plants, 100, 25 and 1 p.p.m. aqueous solutions of gibberellic acid. Records of the average time taken from sowing to anthesis and of the number of leaves developed on the main axis before the appearance of the first flower bud were kept.

Leaves on the treated plants of *Cicer* and *Linum* developed slight chlorosis and on the former there was overcrowding in the apical region at an advanced age.

Spraying and dropping treatments with 100 and 25 p.p.m. of gibberellic acid brought about an extra growth in length in both vernalized and normal plants of *Cicer* and *Lens*, but there was scarcely any effect on *Linum*. In *Brassica*, an early elongation of the shoot was recorded only in the unvernalized plants, but there was barely any difference in the final height of the treated and untreated ones. Rudimentary flower buds could be detected in both normal and vernalized plants of *Brassica* as soon as the shoot started to elongate, but in the plants treated with gibberellic acid this is possible only when they attain a certain height. This confirms the findings of several workers[1–3]. Statistically significant earliness in flowering was obtained only in unvernalized plants of *Brassica* subjected to repeated applications of 100 p.p.m. of gibberellic acid (Table 1).

In the present investigation, seed treatments of all the four plants with gibberellic acid failed to produce any earliness in flowering; hence it may be concluded that this chemical does not replace 'vernalin'. Application of gibberellic acid to growing plants, too, is effective only in *Brassica*, but the degree of earliness induced is rather poor when compared with that resulting from chilling. Thus, for example, in the sowing of October 4, 1957, gibberellic acid treatment brings about an earliness in flowering of 8·0 days, and a reduction of 1·2 in the number of leaves; for plants raised from maximally vernalized seeds the corresponding figures were 23·1 days and 7·3.

Induction of early flowering is one of the many effects of vernalization. Among others, mention may be made of stem elongation in certain rosette-forming plants and several morphological changes, such as the shortening of the first leaf in winter wheat and rye, change in the shape and margin of the leaves in *Cichorium intybus* and a diminution in the length of the hypocotyl and area of the cotyledonary leaves

Table 1. Effect of a 100-p.p.m. Aqueous Solution of Gibberellic Acid on the Flowering of *Brassica campestris* L. Number of Plants are given in Brackets

Date of sowing	Mode of application	Time taken for anthesis in days		Leaf number	
		Gibberellic acid	Control	Gibberellic acid	Control
Aug. 24, 1957	5 sprays, one every 3 days, starting at an age of 5 days	52·5 (13)	60·8 (16)	16·1 (13)	18·1 (16)
Oct. 4, 1957	7 drops, one every 3 days, starting at an age of 7 days	50·8 (21)	58·8 (20)	16·0 (15)	17·2 (12)
Nov. 5, 1957	3 sprays, one a week, starting at an age of 7 days	65·1 (20)	71·5 (12)	14·9 (20)	16·9 (12)

in *Phaseolus radiatus*. In annual plants like *Cicer*, *Linum* and *Lens*, the early floral initiation is scarcely associated with an extra elongation of the stem of the type met with in the biennial plants. In the rosette-forming brussels sprouts, Verkerk[4] has demonstrated that stem elongation and flower initiation are two separate actions of the vernalization treatment. In gibberellic acid treatment also these two actions are separate, but a fundamental difference exists between the vernalization and gibberellic acid effects, as in the former, the flower buds become visible almost simultaneously with that of extension growth, while in the latter it is not so[2,3,5].

This investigation is further support[6] for Lang's suggestion that the primary effect of gibberellic acid is on stem growth, flower formation being brought about indirectly.

I am greatly indebted to Eli Lilly and Co. for the supply of gibberellic acid used in these experiments.

S. C. CHAKRAVARTI

Department of Botany,
Government Hamidia College,
Bhopal.
Aug. 25.

[1] Bukovac, M. J., and Wittwer, S. H., *Mich. Agric. Exp. Stat. Quart Bull.*, **39**, 650 (1957).
[2] Lang, A., *Proc. U.S. Nat. Acad. Sci.*, **43**, 709 (1957).
[3] Harrington, J. F., Rappaport, L., and Hood, K. J., *Science*, **125**, 601 (1957).
[4] Verkerk, K., *Proc. Kon. Nederl. Akad. Wet., Ser.* C, **57**, 339 (1954).
[5] Lona, F., *Nuovo Giorn. Bot., Ital.*, N.S., **63**, 61 (1956).
[6] Chakravarti, S. C., and Abraham, N. J., *Proc. Nat. Inst. Sci. India*, B, **24**, 89 (1958).

Response of Cacao to Fertilizers

Cunningham and Lamb[1] have recently described an experiment in Ghana which demonstrated the response of cacao to fertilizers both with and without shade. These results serve to confirm more intensive studies, made at the Imperial College of Tropical Agriculture in recent years, which have resulted in the development of a general theory of the interaction of shade and nutrition in the growth and cropping of young cacao.

A statistically designed field experiment was planted using an artificial shade of slats to let through different percentages of full sunlight. Each shade treatment carried a $2 \times 2 \times 2$ factorial nitrogen–phosphorus–potassium layout with the fertilizers present or absent. Clonal cuttings were used as planting material.

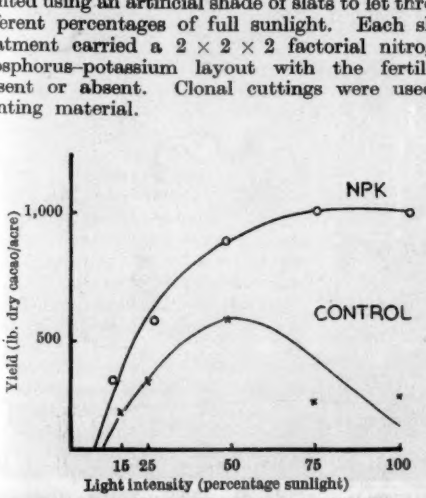


Fig. 1. Relation of yield (lb. dry cacao/acre) to light intensity for control and fertilizer plots

The yields at three years of age for the control and fertilizer plots are shown in Fig. 1. From this it is clear that with light intensities less than some 50 per cent of full light, light is limiting to yield. At more than 50 per cent light, however, the drop in yield of the control plots as compared with the increasing yield of the fertilizer plots indicates that nutrition is now limiting to yield. The results have been described in detail by Evans and Murray[2] and by Murray[3], together with the effects of shade removal and such changes in leaf analysis as occur under different shade conditions.

It is obviously impossible to consider either the shade or the nutritional requirements of cacao independently. In addition, the relationship is dynamic, varying with increasing size of tree and consequent self-shading. This interaction of light intensity with the nutritional status of the tree is of great importance in the agronomy of the crop.

D. B. MURRAY

Regional Research Centre,
Imperial College of Tropical Agriculture,
Trinidad.

[1] Cunningham, R. K., and Lamb, J., *Nature*, **182**, 119 (1958).
[2] Evans, H., and Murray, D. B., Report on Cacao Research 1945–51, 67 (Imp. Coll. Trop. Agric., Trinidad, 1953).
[3] Murray, D. B., Report on Cacao Research 1952, 11; Report on Cacao Research 1953, 30; Report on Cacao Research 1954, 32 (Imp. Coll. Trop. Agric., Trinidad, 1953–55).

Yield Variations in Tree Crop Experiments with Specific Reference to Cacao

IN the past, large yield fluctuations within treatments in cacao fertilizer experiments have proved difficult to understand. These fluctuations, frequently occurring between adjacent trees, necessitate an unwieldy degree of replication before a sensible level of error variance is obtained within the experimental area. It is important to know the cause of these fluctuations, not only to reduce to a minimum the acreage required for field-experimentation with cacao but also to help in understanding the behaviour of tree crops and of cacao in particular.

Results from the long-term fertilizer trials on cacao conducted by this Department[1] have now shed some light on this problem. Thus in Fig. 1 mean cacao yields of *ICS* 1 clones obtained during the sixth, seventh and eighth years since these trials were planted, have been plotted against tree girths at $3\frac{1}{2}$ years of age. The degree of correlation between these two factors was highly significant (at $P = 0{\cdot}001$ level).

It is clear from this relationship that, so far, the yielding capacity of the trees and the variation in yield have been largely determined by uncontrolled variables operative during the first few years following the establishment of the experiment. The effect of these variables was reflected in the varying measurements of girth at $3\frac{1}{2}$ years of age. It is suggested that these variables are associated with traditional methods of cacao establishment.

Traditionally, young cacao is permitted a heavy degree of ground shade while its root system is attaining vigour. This is sensible, except that in practice these conditions deteriorate into heavy bush encroachment. In cacao-growing areas where there is a marked dry season—as in Trinidad—this inevitably means intense competition for soil moisture as well as nutrients. If weed competition and soil

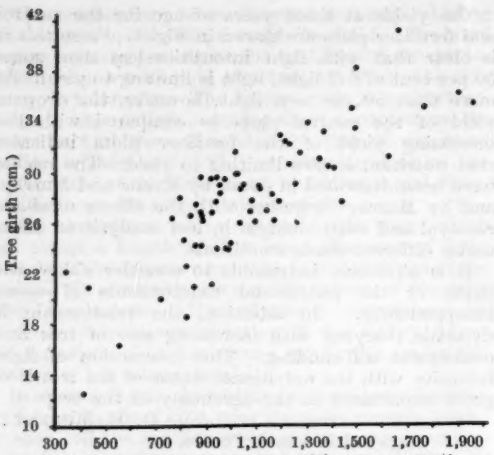


Fig. 1. Cacao tree size/yield correlation ($r = 0{\cdot}810$: for $P = 0{\cdot}001$ $r = 0{\cdot}380$)

moisture deficits are not controlled during the early stages of establishment—and Fig. 1 suggests that young cacao is particularly sensitive to adverse factors in its environment—then extreme variability in yield can be expected later.

Fig. 1 implies that traditional procedure is infringing a fundamental principle of plant science. This principle simply contends that a check to development in plants is permanent and cannot be rectified by later attempts at amelioration. The same principle has also been recognized to a restricted extent in animal studies[2], and its general acceptance lays emphasis on good management for precise control of field experiments. It has, too, equally relevant practical importance in good farming and successful agriculture.

From the point of view of plant science, it raises a critical issue in the measurement of fertilizer response. If the evaluation of fertilizer response at a given site is to be scientifically unimpeachable, then environmental effects—and the word environment is used in its fullest implication—must all operate in the direction of improved plant-growth. The net effect on plant-growth of all individual environmental effects is the algebraic sum of those effects. If any single effect is unintentionally given a negative sign, limitations to growth will be other than those intentionally imposed within the limits of the statistical layout used. The arithmetical order of an environmental factor with a negative sign may completely swamp response to a fertilizer. This has certainly been the case in many fertilizer experiments on cacao in the past.

A full account of this work will be reported elsewhere.

T. A. Jones
G. K. Maliphant

Soil Survey and Research Department,
Regional Research Centre,
Imperial College of Tropical Agriculture,
Trinidad.

[1] Havord, G., A Report on Cacao Research, 1945–51, pp. 104–8; *ibid.*, 1952, pp. 44–46. Havord, G., Maliphant, G. K., and Cope, F. W., *ibid.*, 1953, pp. 80–87; *ibid.*, 1954, pp. 58–64, 65–68 (Imperial College of Tropical Agriculture, Trinidad).

[2] Hammond, J., "Progress in the Physiology of Farm Animals", **2**, 395 (Butterworths, 1955).

The Macronucleus of *Spirostomum*

The purpose of this communication is to describe an interesting property of the macronucleus of a species of *Spirostomum*, a large freshwater ciliate. The nuclear apparatus of this animal consists of a long cylindrical macronucleus and a number of small micronuclei. The cytology of this species has been described by Seshachar and Padmavathi[1]. Feulgen preparations show a number of granules of varying sizes in the macronucleus embedded in a more homogeneous matrix.

During certain regeneration experiments in this laboratory, it was noticed that the macronucleus is highly extensile and could be stretched to a great length. An easy and simple method was to hold one end of the animal down on a slide and pull the other end with a needle. The body ruptures, but the macronucleus can be pulled out until a long, thin strand results. A number of such attempts were made and were almost always successful, and several macronuclei pulled to varying lengths were obtained. They were then fixed and stained with Feulgen. Fig. 1 shows: (*a*) the normal macronuclei of the vegetative animal, and (*b*) a nucleus partially stretched. One macronucleus was pulled to such a length that five separate photographs had to be taken to include the whole. [This photograph was too long for reproduction on the same scale as the others.—Editors.] The maximum length to which a 0·18-mm. macronucleus could be pulled out was nearly 2·72 mm., which is more than fifteen times the original. Further stretching almost always resulted in its snapping.

Similar observations were made on another species, *S. ambiguum*. In this species, the macronucleus is moniliform, with clear swellings and slender connexions between them. When stretched, the lengthening occurs at the expense of the swellings and the resulting body is a greatly elongated uniform strand.

This is probably the first record of the nucleus of any animal cell displaying such remarkable extensile properties. Recent examination with the electron

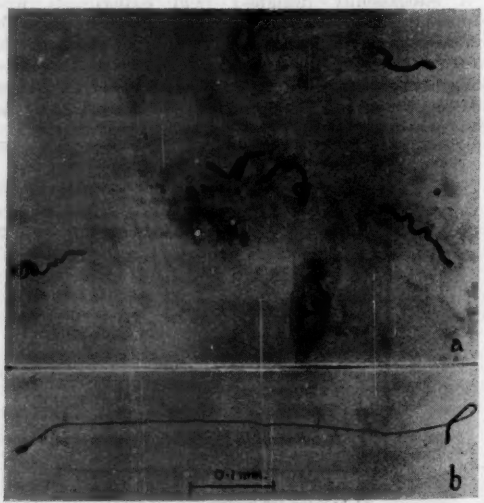


Fig. 1. Photographs of Feulgen preparations of the macronucleus of *Spirostomum* sp. (*a*) Nucleus of normal vegetative animal; (*b*) nucleus partially stretched

microscope has shown that the ciliate macronucleus, like the nucleus of other more typical cells, possesses a double membrane with perforations[1]. The amphibian oocyte nucleus, which was among the first to be examined with the electron microscope[2], has a membrane which readily ruptures under the slightest pressure and is presumably different from that of the macronucleus, which must have remarkable powers of resistance to mechanical manipulation and great extensile properties. It would be interesting to see how the nuclear membrane is accommodated to the stretching possible in *Spirostomum*. That a bounding membrane exists, even in this maximum stretched state, seems beyond doubt.

B. R. Seshachar

Department of Zoology,
Central College,
University of Mysore,
Bangalore.

[1] Seshachar, B. R., and Padmavathi, P. B., *J. Protozool.*, **3**, 145 (1956).
[2] Rudzinska, M., and Porter, K. R., *J. Protozool.*, **2**, 5 (1955), Supplement. Zebrun, W., *ibid.*, **4**, 22 (1957), Supplement.
[3] Callan, H. G., and Tomlin, S. G., *Proc. Roy. Soc.*, B, **137**, 367 (1950).

Embryology of *Atkinsonia ligustrina* (A. Cunn. ex F. Muell.) F. Muell.

The embryology of *Atkinsonia ligustrina*, a root parasite of the Loranthaceae[1] endemic to Australia, has so far remained uninvestigated. The present account is based on a study of some specimens of this plant kindly sent by Prof. H. S. Mckee of the University of Sydney.

The first important point arising from this work concerns the nature of the calyculus. In the Loranthaceae this is generally devoid of a vascular supply, and its morphological nature has consequently been much debated. Roxburgh[2] and Bentham and Hooker[3] considered it to be a true calyx and Danser[4] conceded the same "on practical grounds". On the other hand, Eichler[5] considered it to be an axial structure, and this view was supported by Engler and Prantl[6] and by Schaeppi and Steindl[7]. Narayana's[8] report concerning the presence of vascular bundles in the seven-toothed calyculus of *Nuytsia floribunda* supports Bentham and Hooker's view of the sepaline nature of the calyculus. The feeble vasculature in the calyculus of *Atkinsonia* (Figs. 1 and 2) appears to be a connecting link between *Nuytsia* and the other Loranthaceae in which the calyculus is devoid of a vascular tissue.

Atkinsonia also differs from most other Loranthaceae in having spherical pollen grains (Fig. 3). The only other plant of the family which shows a similar condition is *Tupeia antarctica*[9,10].

In the development of the embryo sac a six-nucleate stage (two nuclei in the upper end of the gametophyte and four in the lower) precedes the usual eight-nucleate condition. The four nuclei at the upper end give rise to the egg apparatus and the upper polar nucleus. Three out of four nuclei at the lower end organize themselves quite early into the antipodal cells, whereas the fourth functions as the lower polar nucleus. As in *Macrosolen*[11], the lower end extends downward leaving behind the antipodals *in situ*. The upper ends of the embryo sacs extend to the base of the style and often show one or two small apical extensions, which probably have a haustorial function.

The fusion of the polar nuclei always takes place below the egg. The first division of the zygote is vertical and subsequent divisions are transverse, resulting in a biseriate pro-embryo. Due to the elongation of the suspensor, the embryo is pushed downward into the collenchymatous tube (Fig. 4). The endosperm is cellular and, as in other Loranthaceae, the endosperms of all the embryo sacs unite to form a composite structure with eight deep lobes in the mature fruit.

The pericarp comprises the outer leathery coat followed by the viscid layer, a zone of several layers of sclerotic cells, and the crushed vascular tissue (Fig. 5). The sclerotic zone, which is responsible for the drupaceous nature of the fruit, is uncommon in the Loranthaceae.

Our knowledge of the subtribe Gaiadendrinae, which includes only two genera—*Atkinsonia* and

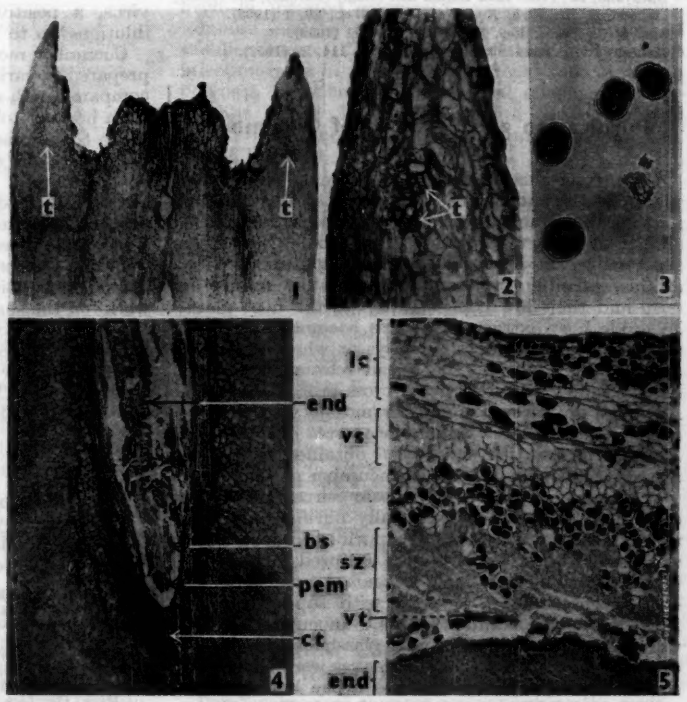


Fig. 1. Long. section of the upper part of ovary showing tracheids in the calyculus (× 33). Fig. 2. Magnified view of tracheids (× 8). Fig. 3. Pollen grains (× 126). Fig. 4. Part of ovary showing the pro-embryo with a broad suspensor (× 37). Fig. 5. Portion of pericarp (× 30). (Key: *bs*, broad suspensor; *ct*, collenchymatous tube; *end*, endosperm; *lc*, leathery coat; *sz*, sclerotic zone; *t*, tracheids; *vs*, viscid layer; *vt*, vascular tissue)

Gaiadendron—is very meagre, and it is likely that *Gaiadendron* may also show some interesting points.

The spherical shape of the pollen grains and drupaceous nature of the fruit suggest a close relationship between the Loranthaceae and the Santalaceae.

In recent years the embryology of many members of the Santalaceae (*Comandra*, *Exocarpus*, *Leptomeria*, *Mida*. *Osyris*, *Santalum* and *Thesium*) and Loranthaceae (*Amyema*, *Barathranthus*, *Helicanthes*, *Lepeostegeres*, *Lysiana*, *Macrosolen*, *Nuytsia*, *Peraxilla*, *Tapinanthus*, *Tapinostemma*, *Taxillus* and *Tolypanthus*) has been studied in this Department. It would be greatly appreciated if fellow botanists will help in procuring specimens of *Buckleya*, *Choretrum*, *Fusanus*, *Myoschilos*, *Nestronia*, *Omphacomeria* and *Pyrularia* of the Santalaceae, and *Aëtanthus*, *Diplatia*, *Gaiadendron*, *Hyphear*, *Psittacanthus* and *Tupeia* of the Loranthaceae.

I wish to thank Dr. B. M. Johri and Prof. P. Maheshwari for valuable suggestions and comments.

Sudha Garg

Department of Botany,
University of Delhi,
Delhi 8.

[1] Mckee, H. S., *Nature*, **170**, 40 (1952).
[2] Roxburgh, W., "Flora Indica" (Calcutta, 1874).
[3] Bentham, G., and Hooker, J. D., "Genera Plantarum" (London, 1883).
[4] Danser, B. H., *Bull. Jard. Bot. Buitenz.*, **11**, 233 (1931).
[5] Eichler, A. W., "Blüthendiagramme" (Leipzig, 1878).
[6] Engler, A., and Krause, K., in Engler, A., and Prantl, K., "Die natürlichen Pflanzenfamilien" (Leipzig, 1935).
[7] Schaeppi, H., and Steindl, E., *Vjschr. Naturf. Ges., Zürich*, **87**, 301 (1942).
[8] Narayana, R., Proc. 42nd Indian Sci. Congr. (Baroda), 239 (1955).
[9] Danser, B. H., *Verh. Kon. Ned. Akad. Wet.*, **29**, 1 (1933).
[10] Smart, C., *Trans. Roy. Soc. N.Z.*, **79**, 459 (1952).
[11] Maheshwari, P., and Singh, B., *Bot. Gaz.*, **114**, 20 (1952).

Purification and Serology of Cucumber Mosaic Virus

Cucumber mosaic virus causes many important plant diseases and occurs as a group of strains differing in their host-range, symptoms produced, transmissibility and other properties. Few studies have been reported on the serological relationships among these strains, possibly because of their labile nature *in vitro* and their low concentration in the host plant. In crude host extracts the virus becomes non-infectious when stored for a few days or when diluted to approximately 10^{-3}. The strain relationships have been studied previously by cross-protection tests. Although antisera to cucumber mosaic virus[1,2] have been claimed, later attempts[3] were unsuccessful. Antisera of low titre have been obtained to tomato aspermy[4,5], a virus related to cucumber mosaic virus.

A strain of cucumber mosaic virus previously described[6] has now been partially purified and used to produce an antiserum. The purification procedure was as follows. The virus was cultured in leaves of tobacco plants (*Nicotiana tabacum* L. var. Havana 425) mechanically inoculated with sap of corollas from infected cucumber plants. Inoculated plants were grown at 24–30° C. in a glasshouse from May until October. The inoculated leaves were harvested, the mid-veins removed and the tissue homogenized at 3° C. in 0·5 *M* potassium phosphate buffer (*p*H 7·5) containing 0·1 per cent thioglycollic acid (1·25 ml. of buffer for each 1·0 gm. of leaf tissue). The homogenate was squeezed through a glass-wool pad and *n*-butanol was added dropwise to the constantly stirred filtrate to give a concentration of 8·5 per cent. The mixture was stirred for a further 30 min. during which time the chloroplastic material was precipitated. The precipitate was separated by centrifuging at 5,000 r.p.m. for 10 min. and the clear, amber-coloured supernatant was filtered through glass-wool. The virus was sedimented by centrifuging the filtrate at 30,000 r.p.m. for 2 hr. in a No. 30 rotor of a 'Spinco' model *L* ultracentrifuge. After ultracentrifugation the supernatant was discarded, the centrifuge tubes drained and the pellet in each tube dispersed in 0·5 ml. of 0·05 *M* potassium phosphate buffer at *p*H 7·5. Resuspension of the virus was continued by mechanical shaking for 2 hr., after which the suspension was clarified by centrifugation at 5,000 r.p.m. for 10 min. The faintly opalescent supernatant containing the virus was carefully withdrawn.

The virus preparations were assayed for infectivity by inoculating the young, expanding primary leaves of cowpea (*Vigna sinensis* Endl. var. Black) on which necrotic local lesions developed, usually within 24 hr. The dilution end-point of the virus in these preparations varied from 10^{-3} to 10^{-5} when diluted in 0·05 *M* buffer. The longevity of the virus in these preparations was greater than that generally reported[7]; one preparation was infectious after 45 days when stored at 3° C. The infectivity in this case, however, was about one-half of that of the freshly purified virus.

Rabbits were injected intravenously at four to five day intervals with 4 ml. of virus prepared as described. Injections were repeated six times and the rabbits were bled six days after the last injection. When the rabbit serum was used for precipitin tests with the virus, a positive reaction was obtained at serum dilutions up to 1/1024.

Cucumber mosaic virus, purified as described, was prepared in various ways for electron microscopy and compared with similarly treated control preparations from healthy tobacco leaves. Samples were sprayed on to collodion-coated electron microscope grids and allowed to air dry. The specimens were shadowed with uranium. When examined with an *RCA* type electron microscope, the grids sprayed with the virus preparations showed numerous, uniform spheres with a mean diameter of 40 mμ. These spheres were not found on grids sprayed with the control preparations. These observations are in agreement with previous work[6] on the shape of cucumber mosaic virus.

Full details of this work will be published later.

We wish to express our thanks to Dr. P. Kaesberg, Mr. Bockstahler and Mrs. Sachs of the Department of Biochemistry, University of Wisconsin, for the assistance given with the electron microscope studies.

J. A. Tomlinson*
R. J. Shepherd
J. C. Walker

Department of Plant Pathology,
University of Wisconsin,
Madison.
Sept. 29.

* On leave from the National Vegetable Research Station, Wellesbourne, Warwick, as a Fellow of the W. K. Kellogg Foundation, to which grateful acknowledgment is made.

[1] Birkeland, J. M., *Bot. Gaz.*, **95**, 419 (1934).
[2] Chester, K. S., *Phytopath.*, **27**, 903 (1937).
[3] Bawden, F. C., "Plant Viruses and Virus Diseases" (Waltham Mass., Chronica Botanica Co., 1950).
[4] Noordam, D., *Tijdschr. Plziekt.*, **58**, 121 (1952).
[5] Govier, D. A., *Ann. App. Biol.*, **45**, 62 (1957).
[6] Sill, W. H., Burger, W. C., Stahmann, M. A., and Walker, J. C., *Phytopath.*, **42**, 420 (1952).
[7] Smith, K. M., "A Textbook of Plant Virus Diseases" (Churchill, London, 1956).

Observations on the Spread of Mouse Polyoma Virus Infection

THE tissue culture growth of the mouse parotid tumour virus, referred to by Stewart *et al.*[1] as "SE polyoma virus", has led to the development of rapid methods for its demonstration and determination, and to practical and specific serological techniques for antibody determinations as well[1–5]. We have made preliminary observations on the distribution of antibodies in various mouse colonies and on the excretion of virus.

Uninoculated mice of six breeder colonies were bled individually, and the sera tested for complement fixing and hæmagglutination inhibiting antibodies, the latter test using 16 hæmagglutinating units. Close correlation was found between the two tests[6]. Hæmagglutination inhibitory antibody at 1 : 200 or greater, or at 1 : 100 in serum treated with receptor-destroying enzyme of *V. cholera*, was considered positive. Table 1 summarizes the frequency with which antibody was detected in mice of the various colonies. Three colonies appeared completely free of infection, while the others had infection in almost all strains tested. Antibody was found predominantly in mice more than three months of age. No evidence of strain specificity of infection was observed; for example, adult *AKR* mice had infection-rates ranging from 5 to 100 per cent in the three infected colonies, while none of 84 adult *AKR* mice in the Jay–Poiley colony was positive.

Table 1. INCIDENCE OF ANTIBODY TO POLYOMA VIRUS IN SIX MOUSE COLONIES

Colony	No. of of mice positive/No. tested		No. of strains or sublines positive/No. tested
	1–3 months old	>3 months old	
Andervont (N.I.H.)		0/95	0/4
Gross (New York)	1/61 (2 per cent)	49/58 (84 per cent)	4/5
Jackson Memorial Laboratory (Bar Harbor)	1/53 (2 per cent)	5/85 (6 per cent)	3/4
Jay–Poiley (N.I.H.)	0/539	0/536	0/19
Law (N.I.H.)	5/120 (4 per cent)	149/406 (37 per cent)	15/16
Microbiological Associates (Bethesda)		0/62	0/3

It is probably significant that two of the three negative colonies are maintained in separate quarters and by personnel who do not handle experimental mice, while the three infected colonies are located physically in proximity to experimental colonies and work with polyoma virus and mouse leukæmias, and are cared for by the same personnel. In the Law colony, antibody-rates in uninoculated mice 6–11 months old were 59 per cent (36/61) in mice in the room with new-born mice inoculated with polyoma virus, 39 per cent (36/92) in the room with adults which received the virus as new-borns, and 13 per cent (13/101) in a room which does not house animals inoculated with virus. Also, mice brought into our laboratory from the Jay–Poiley colony as new-borns and inoculated with uninfected control tissue culture fluids have become antibody positive after 4–6 months in about 30 per cent of individuals tested.

In the Law colony, serological conversions in mice re-bled after 2–4 months were somewhat more frequent in mice one to five months of age when bled initially (19 of 48 converted) than in mice more than six months old (12 of 47 converted).

To determine the source of the apparent environmental contamination, the following tests for virus were made. Urine and mouth swabs were taken from 8 mice which had been inoculated with virus as new-borns five to ten weeks previously; these mice were in five different cages, and the bedding and drinking water of each cage were also sampled. The virus detection procedure employed was based on the production of antibody in adult mice inoculated intraperitoneally (mouse antibody production test); this procedure has been found to be highly sensitive for detection of virus[6]. A suspension of the material tested was inoculated intraperitoneally into three weanling mice from the Jay-Poiley colony, and three weeks later their sera were tested for hæmagglutination-inhibiting antibody. 84 control mice inoculated with saline were distributed in the jars with the test mice, and none developed antibody. Seven of the eight urine specimens were positive for virus, as were all eight mouth swabs, all five bedding samples, and four of the five drinking bottles.

Inhalation may be the means of entry, since we have found that mice can be infected as new-borns or adults by intranasal instillation of 10^2 to 10^3 intraperitoneal immunizing doses, but as yet we have not been able to infect by feeding.

These results suggest that environmental contamination is important in the spread of polyoma virus, and that cross-infection is to be expected in laboratories working with the agent. The implication that infection is generally acquired at several months of age would explain the rarity of spontaneous occurrence of the characteristic parotid tumours, even in infected colonies[7,8], since, experimentally, tumours can be produced only by inoculation of suckling mice. The great variation in polyoma infection-rates in various *AKR* stocks indicates that polyoma virus bears no etiological relation to spontaneous *AKR* leukæmia, despite their repeated association[8], since high leukæmia-rates are found in all *AKR* stocks.

WALLACE P. ROWE
JANET W. HARTLEY
ISADORE BRODSKY
ROBERT J. HUEBNER
National Institute of Allergy and Infectious Diseases,
LLOYD W. LAW
National Cancer Institute,
National Institutes of Health,
Bethesda, Maryland. Sept. 26.

[1] Stewart, S. E., Eddy, B. E., and Borgese, N., *J. Nat. Cancer Inst.*, **20**, 1223 (1958).
[2] Eddy, B. E., Stewart, S. E., Young, R., and Mider, G. B., *J. Nat. Cancer Inst.*, **20**, 747 (1958).
[3] Eddy, B. E., Rowe, W. P., Hartley, J. W., Stewart, S. E., and Huebner, R. J., *Virology*, **6**, 290 (1958).
[4] Eddy, B. E., Stewart, S. E., and Berkeley, W. H., *Proc. Soc. Exp. Biol. Med.*, **98**, 848 (1958).
[5] Rowe, W. P., Hartley, J. W., Brodsky, I., and Huebner, R. J., *Science* (in the press).
[6] Rowe, W. P., *et al.* (in preparation).
[7] Law, L. W., *Ann. N.Y. Acad. Sci.*, **68**, 616 (1957).
[8] Gross, L., *Cancer Res.*, **18**, 371 (1958).

Biochemical Changes in Virus-infected and Regenerating Mouse Liver

THE biochemical changes accompanying the multiplication of an animal virus within its host cell are still largely unknown. Alterations in the levels of activity of a variety of enzymes in mouse brain infected with virus have been reported by Bauer[1].

Table 1

Enzyme	Activity ± standard error in livers			
	Normal	Infected 24 hr.	Regenerating 48 hr.	Infected 20 hr., regenerating 48 hr.
Succinic dehydrogenase	6·38 ± 0·28	8·52 ± 0·33	6·52 ± 0·44	6·34 ± 0·46
Xanthine dehydrogenase	1·39 ± 0·05	2·70 ± 0·11	2·33 ± 0·11	2·49 ± 0·28
Uricase	216 ± 16	283 ± 23	182 ± 30	185 ± 26
Acid phosphatase	69·9 ± 2·7	65·4 ± 6·6	80·4 ± 12·6	46·7 ± 2·38

In this system the number of infected cells is not known and the variety of cell types and possibility of compensatory changes in other neurones make interpretation difficult. Tissue cultures infected with poliovirus show marked changes in various enzyme activities[2], but here the considerable variation in physiological state of the culture produced by small experimental variations must be borne in mind when interpreting results. The effects of a virus on the cells of its natural mammalian host can be studied conveniently in the livers of mice infected with large (10^8–10^{10} *LD*50) intravenous inocula of ectromelia virus[3]. Simultaneous infection of almost all hepatic parenchymal cells takes place, there is no cellular infiltration, and up to 30 hr. after infection there is little or no necrosis. Mouse livers so infected show a progressive increase in size without cell division. The comparison between normal growth in regeneration and that induced by infection, of either normal or regenerating liver, is of some interest. In liver regenerating after partial hepatectomy increase in cell size is followed by cell division, but in regenerating liver infected with ectromelia mitosis is inhibited[4]. Other evidence for nuclear changes is decreased synthesis[5] of coenzyme I and decreased adenosine deaminase activity in both infected and regenerating livers.

There is, however, no evidence to date of synthesis of ectromelia virus by the nucleus. The effects of infection and regeneration on some cytoplasmic enzymes (succinic and xanthine dehydrogenases, uricase and acid phosphatase) have been measured. Activities (per gm. fat-free dry weight) are expressed as μmoles substrate destroyed per minute (dehydrogenases), μgm. uric acid destroyed per minute (uricase) or King Armstrong units (acid phosphatase) (Table 1).

The activity of the succinic dehydrogenase complex is an index of the mitochondrial content of a tissue. There is no change in succinic dehydrogenase activity in regenerating or infected regenerating livers. Since the fat-free dry weight of the regenerating liver fragment has increased by 40 per cent, this represents a synthesis of mitochrondria proportional to liver growth, even though in the latter case cell numbers are not restored. The increase in activity in infected intact livers, which also show cell growth, represents a more than proportional increase in the mitochondrial population of each cell.

Xanthine dehydrogenase activity, localized in the soluble fraction, is increased in both regenerating and infected livers. By its aldehyde oxidase activity[6] this enzyme may play a part in the metabolism of 2-carbon fragments. This would seem more likely than the alternative suggestion that purine catabolizing activity is causally related to increased nucleic acid syntnesis.

Uricase activity is wholly, and acid phosphatase activity partly, associated with the lysosome fraction of the cytoplasm[7]. Changes in activity in regenerating livers are not significant. In infected livers uricase activity is increased while phosphatase is little changed before 24 hr. In infected regenerating livers uricase activity does not differ from that of uninfected controls, while phosphatase activity falls markedly. These findings suggest a considerable alteration in the composition of some subcellular fractions. Uricase/acid phosphatase ratios were determined on three centrifugally separated fractions of the cytoplasm: heavy mitochondria, light mitochondria (including lysosomes) and a supernatant (including microsomes)[7]. The results (expressed in arbitrary units) are shown in Table 2. These findings may be due to either (*a*) changes in the enzymic composition of all members of a particle population which is otherwise little altered; or (*b*) selective damage to some members of a population in which enzyme activity is unequally distributed.

Table 2

Cytoplasmic fraction	Uricase/acid phosphatase ratios in livers		
	Normal	Infected 24 hr.	Regenerating 48 hr.
Heavy mitochondria	7·9	5·9	8·1
Light mitochondria	9·0	10·0	8·8
Supernatant	3·4	1·5	2·8

Marked biochemical changes are induced in the cytoplasm by both infection and regeneration. Cell growth in regeneration may be considered to be normal and orderly, while that in infection is disorderly to the extent that it ultimately results in cell death. This disorder is reflected in differences between some of the changes in infected and regenerating livers. The mechanism of production of the changes in cells infected with virus is still obscure. They may be a direct result of the presence of virus or virus components in the cell; or they may be a secondary response to a change in emphasis of metabolic pathways, produced during the early stages of infection. Studies of the effect of shorter periods of infection may help solve this problem.

This work was supported by a grant from the National Health and Medical Research Council. We wish to thank Mrs. I. M. Stephens for technical assistance.

David S. Nelson
P. M. de Burgh

Department of Bacteriology,
University of Sydney.
Oct. 1.

[1] Bauer, D. J., "The Nature of Virus Multiplication", 46 (Cambridge, 1953).
[2] Kovacs, E., *Proc. Soc. Exp. Biol. Med.*, **92**, 183 (1956).
[3] Nossal, G. J. V., and de Burgh, P. M., *J. Gen. Microbiol.*, **10**, 345 (1954).
[4] de Burgh, P. M., and Miller, J. F. A. P., *Nature*, **175**, 550 (1955). Miller, J. F. A. P., and de Burgh, P. M., *Aust. J. Exp. Biol. Med. Sci.*, **35**, 115 (1957).
[5] de Burgh, P. M., *Aust. J. Sci.*, **20**, 86 (1957).
[6] Richert, D. A., and Westerfeld, W. W., *J. Biol. Chem.*, **227**, 533 (1957).
[7] de Duve, C., Pressman, B. C., Gianetto, R., Wattiau, R., and Applemans, F., *Biochem. J.*, **60**, 604 (1955).

Mutations in L-Forms

CONVERSION of bacteria into L-forms involves changes in physiology as well as morphology. Comparing sensitivity to drugs of L-forms and bacteria, we are struck by the much higher resistance of the former to penicillin. Strains of L-forms of *Proteus* used in our laboratory are able to grow in the presence of 60,000 units penicillin/ml. On the other hand, they are more sensitive to streptomycin, chlortetracycline and chloramphenicol than are the bacterial forms. Tulasne and Minck[1] found that stable L-forms of *P. morganii* were 8,000 times and unstable L-forms of *P. vulgaris* were 25,000 times more sensitive than the corresponding bacterial forms. Lederberg and St. Clair[2] showed a fifty-fold decrease in resistance to streptomycin after converting *Escherichia coli* to the L-form. The authors suggest that "this can be viewed as the negation of the S^R effect when the wall is stripped or a mutual reinforcement of penicillin and streptomycin in respect to another target". They were inclined to accept the former interpretation. Horoszewicz and Horoszewicz[3] noted the inhibitory action of streptomycin on the conversion of *P. mirabilis* to the L-form. In the presence of the antibiotic it was necessary to inoculate 1,800 times more bacteria to obtain the same number of L-colonies.

We have used a stable L-form of *Proteus mirabilis* subcultured more than 100 times on serum-agar and then adapted to charcoal-agar and lately to charcoal-broth[4]. Growth of L-forms in the charcoal media was much more luxuriant than in serum media. In charcoal-broth in 2–3 days, L-organisms formed a remarkable turbidity and some days later a thick, greyish pellicle which could be dispersed on shaking. Usually the number of L-colonies grown from 1 ml. of fluid medium was $2–4 \times 10^8$. Such dense fluid culture was suitable for study of the formation of antibiotic-resistant mutants. Our bacterial strain was inhibited by 10 units streptomycin/ml. while the stabilized L-form was sensitive to 0·0001 unit/ml. For antibiotic sensitivity tests, between 100 and 1,000 organisms were used per plate. To obtain mutants resistant to streptomycin we used 4–10-day old cultures of L-forms in charcoal-broth and added an equal volume of charcoal-broth with streptomycin. It was found that the time and frequency of mutation depended on the number of organisms in the culture. When the total number of L-form particles was 10^{11}, organisms resistant to 500 units streptomycin/ml. soon appeared. In 10 per cent of the flasks containing about 10^9 organisms, mutants resistant to 50 units/ml. appeared first, but after 5 days it was possible to isolate mutants insensitive to 500 units/ml. We did not succeed in isolating mutants resistant to 500 units/ml. from populations of only $3–4 \times 10^7$. Subculturing resistant strains on media with or without streptomycin caused no change in the character of the resistance to antibiotics.

We have also examined the streptomycin sensitivity of unstable L-forms derived from four strains of *Proteus mirabilis* and from their streptomycin-resistant mutants. L-forms obtained from S^R bacteria showed higher resistance than those from S^S organisms. Unstable L-forms derived from streptomycin-resistant bacteria could grow in the presence of 500 units streptomycin/ml., but we noticed that on charcoal-agar containing streptomycin but without penicillin the reversion from L-form to bacterial form was greatly delayed in comparison with that on charcoal-agar without either antibiotic. However, after ten subcultures, the time of reversion became independent of the presence or absence of streptomycin.

L-forms insensitive to 200 units chloramphenicol/ml., obtained by selection, did not show persistent resistance—usually after five or more passages on the medium containing chloramphenicol the culture was completely inhibited.

It was not possible to obtain antibiotic-resistant mutants by ultra-violet irradiation.

Our preliminary investigations suggest that mutants resistant to streptomycin can appear in L-form populations. It has been possible by selection to obtain mutants even more resistant to streptomycin than their corresponding bacterial forms. Probably the highly resistant mutants are formed stepwise rather than as one-step mutants.

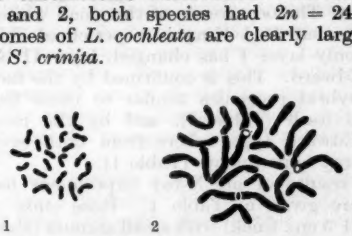
ZB. LORKIEWICZ
IRENA ZELAZNA

Department of General Microbiology,
University of Lublin, Poland.

[1] Tulasne, R., and Minck, R., *C.R. Soc. Biol.*, **146** (9–10), 178 (1952).
[2] Lederberg, J., and St. Clair, J., *J. Bact.*, **75**, 143 (1958).
[3] Horoszewicz, A., and Horoszewicz, J., *Acta Microbiol. Polonica*, **5**, 9 (1956).
[4] Lorkiewicz, Zb., *Acta Microbiologica Polonica*, **6**, 3 (1957).

Somatic Chromosomes of *Leptaspis* and *Streptogyna* (Poaceae)

BOTH *Leptaspis* and *Streptogyna* represent very interesting groups from the point of view of the phylogeny of the Poaceae as their external morphology is very primitive. I collected *Leptaspis cochleata* Thw. and *Streptogyna crinita* Beauv. in woods at Dulva Kanda (about 4,000 ft.) in Ceylon while I was there in 1957. The root tips of the two species were fixed with Navashin solution at the habitats and, after my return to Japan, dehydrated and embedded in paraffin. Sections were cut at 15μ and stained by Newton's gentian violet method. Two individuals of *S. crinita* and one individual of *L. cochleata* were used for chromosome observation. As shown in Figs. 1 and 2, both species had $2n = 24$. The chromosomes of *L. cochleata* are clearly larger than those of *S. crinita*.



1 2

Figs. 1 and 2. Somatic chromosomes. (1) *Streptogyna crinita*. (2) *Leptaspis cochleata*. × 2,000

Leptaspis is characterized by the diclinous spikelets and belongs to the Olyreae. The tribe, which has never been examined cytologically, is distributed in the tropics, the majority of species being concentrated in Central America and the West Indies. From anatomical investigations of leaf and embryo, as well as morphological studies, the Olyreae are assumed to be distantly related to the Bambuseae. A number of Bambuseae species examined cytologically up to now have had $2n = 48$ or 72, suggesting the basic chromosome number of 12, whereas a few have $2n = 36$ or 54. *Leptaspis cochleata* is similar to the Bambuseae in the basic chromosome number, but the chromosomes of *Leptaspis* are somewhat larger.

Streptogyna has been referred to an independent tribe, Streptogyneae, by C. E. Hubbard[1]. The genus includes two closely related species which inhabit the tropics. *Streptogyna* had been traditionally treated as a member of the Centotheceae or Festuceae, but the leaf structure of the genus apparently indicates a relationship with the Bambuseae[2]. Streptogyneae and Bambuseae also share some common features in external morphology; for example, in respect to the lodicules the two groups are closely related. Also the chromosomal features of *Streptogyna*, clarified for the first time by the present observation ($b = 12$ and small chromosome sizes), are similar to those of the Bambuseae.

T. Tateoka

National Institute of Genetics,
Misima,
Sizuoka Pref., Japan.

[1] Hubbard, C. E., *Hook. Ic. Pl.*, **36**, Tab. 3572 (1956).
[2] Jacques-Felix, H., *J. Agric. Trop.*, **2**, 427 (1955). Metcalfe, C. R., *Bot. Mag. Tokyo*, **69**, 391 (1956).

Transformation of a Monochlamydius into a Dichlamydius Chimæra by X-ray Treatment

According to Asseyeva[1], X-ray treatment of potatoes is "a powerful and reliable means of transforming monochlamydes into dichlamydes". No details of the treatment used are given in this paper, nor do any appear to have been published in a later paper. It is therefore of some interest to report an X-ray treatment that has given a successful transformation for the potato variety Red King, particularly as similar treatments might also work with periclinal chimæras in plants other than potatoes.

Red King arose as a 'bud sport' in the variety King Edward. It has tubers which are full pink (the pigment is in the periderm, which in potato tubers originates nearly entirely from the epidermis) except for small white patches at the heel end and beneath some of the eyes, whereas King Edward has tubers which are white with pink splashes around the eyes. The occurrence of the small white patches suggests that Red King is a periclinal chimæra in which only layer I has changed, layer II being still King Edward. This is confirmed by the fact that it gives hybrid progenies similar to those from King Edward itself (Table 2), and by the recovery of King Edward type tubers from both eye-excision and X-ray experiments (Table 1).

The results of an X-ray experiment using Red King are given in Table 1. Rose ends of tubers (about 1·5 cm. thick) with small sprouts (about 4 mm. long) were X-rayed by the Department of Radiotherapeutics, University of Cambridge, using a 200-kV. 'Maximar' X-ray machine, run at 15 m.amp. The different dosages were given by exposing them for 6, 7, 8 and 9 min. at 6·75 cm. from the aluminium filter. The highest dosage was lethal to all the sprouts on the treated rose ends. The plants grown from the rose ends receiving lower dosages produced tubers of a number of types, and they included one plant which had tubers of the Red King type but without the small white areas. This is the type to be expected where both layer I and layer II are Red King, and that this was so is confirmed by the breeding results (Table 2)—thus, in contrast to the seedlings from King Edward and normal Red King, the seedlings with coloured tubers in its progeny have full colour and not white with coloured splashes.

Table 2

Parents of cross	No. of plants with tubers of types		
	Full colour	White splashed colour	White
King Edward × white	0	7	12
Red King × white	0	11	19
Full pink from X-rayed Red King × white	5	0	6

The other types of tubers produced by the X-rayed plants have not been studied fully. It should, however, be noted that the plants with white tubers were expected since similar tubers are found in eye-excision experiments with King Edward, Red King and even with white-splashed-colour type seedlings bred from King Edward (ref. 1 and Howard, unpublished work).

H. W. Howard

Plant Breeding Institute,
Cambridge. Sept. 22.

[1] Asseyeva, T., *Bull. App. Bot., Leningrad*, **27**, iii, 194 (1931) (English text).

Gene Control of Specificity and Activity: Loss by Mutation and Restoration by Complementation

The *S* gene, controlling the incompatibility reaction between pollen and styles in plants, exists in a very large number of 'alleles', each producing a characteristic antigen in the pollen and a similar antigen with the same specific activity in the style, through which the pollen tube must grow to achieve fertilization. Mutations and recombination of this gene in *Oenothera organensis*, selected out of 10^9 genes, have been of one type only[1]. The chief feature about these mutant *S* alleles is their complete loss of activity in the pollen, so that no active antigen could be detected by the sensitive pollen-style tests. The favoured[2] interpretation was that one part or area of the gene was determining specificity and another area determining a carrier responsible for the activity in pollen and style. The mutant change would then be some defect in the activity-determining area of the gene. With this interpretation it must be concluded that none of the mutants gave an active and changed specificity but only a loss of activity.

Table 1

X-ray dosage (r.)	No. of rose ends treated	No. of rose ends producing plants	No. of plants with tubers of types:					
			Full pink	Red King	Red King plus King Edward	Intermediate Red King–King Edward	King Edward plus white	White
4,500	4	0	—	—	—	—	—	—
4,000	4	3	0	2	0	0	1	0
3,500	4	3	1	0	1	0	0	1
3,000	4	4	0	2	0	1	1	0

The results, however, did not entirely exclude an interpretation based upon two genic areas that determine specificity, one for the pollen and the other for the style. A mutation to a changed specificity in the pollen, unaccompanied by a change in the stylar-determining area of the gene, would be indistinguishable by the tests from a loss of pollen activity. Because of the totally unexpected absence of mutants or recombinants, which results in a changed specificity of pollen and style, when the tests should have revealed them even in low frequency, it was necessary to discriminate between the two interpretations. The experiments designed for this purpose reported here were based upon the comparison of interactions of the mutant with the normal alleles in diploid pollen of artificially produced autotetraploids.

The normal S alleles when in pairs in diploid pollen grains of a tetraploid give a characteristic pattern of the three types of gene interaction—dominance, recessiveness and competition[3,4]. On the two-specificity interpretation of the mutants there are two possibilities: (1) The mutant alleles could have lost the pollen specificity-determining area, in which case there would be no interactions in diploid pollen. (2) The mutant had a changed specificity, in which case the pattern of interactions would be changed. On the one-specificity one-carrier interpretation in which we can postulate only a loss of activity in the pollen for the mutants, there are again two possibilities: (1) There could be a defect or block at a primary stage in gene activity, in which case the mutant allele will show no interactions. (2) The mutant allele might be active in one or more of the early stages of gene action but fails in the later stage to attain final phenotypic expression in the form of the characteristic antigen. If the experiments show that mutant S alleles do not interact in diploid pollen grains, then there is no discrimination between the two interpretations of the structure of the S gene, but on both interpretations this would mean an exclusion of the possibility that the mutations resulted in changed specificity. If, on the other hand, the tests show that the mutant alleles do interact with other alleles, then a discrimination can be made both on the structure of the genes and on the nature of the mutations.

The interactions found with the mutant alleles are compared with those of the original alleles in Table 1. The pattern of interactions is essentially unchanged, thus confirming the one-specificity one-carrier interpretation. But one new and highly significant interaction was found in the pollen grains with S_2 and S_4' alleles. The original allele S_4 is almost completely independent of S_2 in the diploid pollen grain. This was shown by the inhibition of $S_{2,4}$ pollen in styles with either S_2 or S_4 alone and by a stronger inhibition in an $S_{2,4}$ style. The $S_{2,4}{}^1$ pollen grains are inhibited in S_2 styles, little or not at all in S_4 styles, but the inhibition on $S_{2,4}$ styles is complete and fully as strong as the inhibition of an $S_{2,4}$ pollen grain. Thus the $S_4{}^1$ allele, inactive as it is in a haploid pollen grain, is restored to activity when accompanied by an S_2 allele. The S_2 restores the activity of $S_4{}^1$ not by imposing its own specificity but by allowing $S_4{}^1$ to produce its own original characteristic specificity.

This situation is most nearly paralleled by the restorer genes in *Neurospora* which restore the production of the active enzyme tryptophan desmolase in mutants which lack the enzyme. The enzyme appears to be absent in the mutants, but serological tests show that there is a protein present which is serologically identical with the active enzyme[5]. The complementary action of two different alleles to produce glutamic dehydrogenase in *Neurospora* heterocaryons is also similar[6]. The new situation in the S gene restoration is that the restorer is an allele of the restored, that both give products with different specificities and that the restored allele shows its original specificity and not that of the restorer. The origin of new specificities by mutation or recombination still remains a problem.

Table 1

	S_1	S_2	S_4	S_5
S_4 (normal)	Strong Comp.	Strong Comp.	S_5 Dom.	—
$S_4{}^1$ (mutant)	Strong Comp.	Comp.	$S_5{}^1$ Dom.	—
S_4 (normal)	Slightly Rec. Indep.	Weak Comp.	—	S_4 Rec.
$S_4{}^1$ (mutant)	Restored to S_4	Weak Comp.	—	$S_4{}^1$ Rec.

Interaction of pairs of alleles in diploid pollen grains to show the comparison between normal and mutant alleles.
Comp., competition; Dom., dominance; Rec., recessiveness; Ind., independent.

D. Lewis

Department of Botany,
University College,
Gower Street,
London, W.C.1. Oct. 28.

[1] Lewis, D., *Heredity*, **5**, 399 (1951).
[2] Darlington, C. D., and Mather, K., "Elements of Genetics" (London, 1949).
[3] Lewis, D., *Heredity*, **1**, 85 (1947).
[4] Atwood, S. S., and Brewbaker, J. K., *Rec. Genet. Soc. Amer.*, **19**, 87 (1950).
[5] Yanofsky, C., in "Enzymes: Units of Biological Structure and Function", 147 (Acad. Press, New York, 1956).
[6] Fincham, J. R. S., and Pateman, J. A., *Nature*, **179**, 741 (1957).

Analogies between the Compensatory Responses of Fish and Crustacea to Horizontal Displacement of the Body

Certain fish make compensatory swimming movements when they are stimulated by passive displacement of the body or by corresponding displacement of the environment. Experimental analysis shows that this response can be elicited by image displacement on the retina[1], by inertial stimuli[2], by tactile stimuli and by the passage of water over the surface of the fish[3].

In crabs and lobsters a similar set of mechanisms has been shown to exist. Buddenbrock and Friedrich[4], and later Dijkgraaf[5] showed that a rotational stimulus alone would produce compensatory eyestalk movements in crabs similar to those produced by a rotation of the visual field, while Dijkgraaf also showed compensatory responses to tactile stimulation of the legs and to water movement in *Palinurus vulgaris* Latreille[6]. Dijkgraaf proved that the statocyst in the crabs *Carcinus moenas* (L.) and *Maja verrucosa* Milne-Edwards was sensitive to angular displacement, and pointed out the similarity between resulting movements of the eyestalks of crabs and the eyes of vertebrates under similar experimental conditions[5]. However, blind *Palinurus*, though possessing a statocyst, failed to show any rotational sense[7]. On the other hand, Cohen found that when the statocyst of *Homarus americanus* Milne-Edwards was rotated, the discharge-frequency of its nerve underwent a change[8].

Similar experiments have recently been carried out on the behaviour of several species of prawns which confirm that there is a close parallel between mechanisms at work in prawns and crabs and those in fish. In both groups there are several mechanisms that detect displacement of the body; these are present in the same animal and are presumably used simultaneously. In *Palaemon serratus* (Pennant) and *Palaemon elegans* Rathke visual, inertial and tactile stimuli elicit compensatory movements of the eyestalks and to a varying extent of the organs responsible for controlling the direction of movement, that is, the antennæ, pleopods and telson. The statocyst has been shown to be essential to enable these animals to respond to rotation in the absence of visual and tactile stimuli. *Pandalus montagui* Leach, which has no statocyst and which does not respond to inertial stimulation, possesses an additional sense which enables it to respond to water movement when it is rotated; this sense normally augments the response to visual and tactile stimuli.

It is interesting to note that of the four possible mechanisms available to give information about the animal's displacement relative to its environment, no particular crustacean so far studied appears to use more than three to control its direction of movement. *Palinurus vulgaris*, although possessing statocysts, resembles *Pandalus montagui* in giving no response to inertial stimuli, but shows compensatory behaviour when stimulated by water currents, while the other prawns and brachyuran crabs[5] give compensatory eyestalk responses to visual, tactile and inertial stimuli but not to water movements.

D. H. A. Marr

Marine Biology Station,
Menai Bridge,
Anglesey.
Sept. 23.

[1] Lyon, E. P., *Amer. J. Physiol.*, **12**, 149 (1905).
[2] Gray, J., *J. Exp. Biol.*, **14**, 95 (1937).
[3] Dykgraaf, S., *Z. vergl. Physiol.*, **20**, 162 (1933).
[4] v. Buddenbrock, W., and Friedrich, H., *Z. vergl. Physiol.*, **19**, [illegible]7 (1933).
[5] Dijkgraaf, S., *Experientia*, **11**, 407 (1955); *Pubbl. Staz. zool. Napoli*, **28**, 341 (1956).
[6] Dijkgraaf, S., *Z. vergl. Physiol.*, **38**, 491 (1956).
[7] Dijkgraaf, S., *Experientia*, **11**, 329 (1955).
[8] Cohen, M. J., *J. Physiol.*, **130**, 9 (1955).

The Teleostean Swim-bladder

The enigmatic secretion of gas into the teleostean swim-bladder has been attributed to the acidification of the blood bathing the gas gland epithelium[1]. The resultant local changes of pH, pCO_2 and pO_2 are thought to be sequestered from the rest of the circulation by counter-current exchange in the rete mirabile. This has been the only credible explanation; but its acceptance has rested upon its credibility. Even though the isolated gas gland epithelium actively converts glucose to lactic acid[2], there has been no evidence, either *in vivo* or *in vitro*, for an oriented hydrogen-ion extrusion into the solution bathing the serosal surface of the epithelium, the surface normally bathed by blood.

The following experiments indicate that the isolated surviving gas gland epithelium of the pollack (*Pollachius virens*, L.) selectively extrudes hydrogen ion into the solution bathing its serosal surface. The gas gland epithelium was dissected free of its serosal coat and exposed to oxygenated saline within 15 min. after removal of the fish from water. The epithelium was mounted as a flat 1-cm.^{2} membrane between simplified chambers[3] that permitted measurement of the trans-membrane potential and membrane conductance. The membrane separated two identical solutions having a volume of 5 ml. and the following composition: sodium chloride 200, potassium chloride 10, calcium chloride 5, magnesium chloride 2, glucose 25 and yohimbine 0·002 mM/l. The solutions were gassed with 100 per cent oxygen and experiments were conducted at an ambient temperature, 22° ± 1·6° C., which was probably supraoptimal. The bathing solutions were removed at 2-hr. intervals and the initial pH recorded after 15 min. of gassing with air passed through a soda-lime column. Using a glass and calomel electrode pair stable and linear within pH 0·05, the solutions were titrated to pH 7·0 with 12 mM sodium hydroxide.

The gas gland epithelia from five fish were observed for two successive 2-hr. periods. The rate of extrusion of hydrogen ions into the bathing solutions, mean and standard deviation of 10 observations, expressed as μequiv. cm.$^{-2}$ hr.$^{-1}$ was 0·53 ± 0·3 into the serosal and 0·08 ± 0·07 into the lumenal solution. The corresponding pH of these solutions was 4·8 ± 0·2 and 6·2 ± 0·8, respectively. The wet weight was 67 ± 37 mgm. Neither the amounts of hydrogen ion extruded nor the resultant hydrogen ion concentrations suggest that these observations were the result of a casual autolytic phenomenon. In my experience the rate of production of lactate by the frog gastric mucosa is 0·08 μequiv./105 mgm. wet weight/hr. It should be noted that the acidification of the solutions bathing the gas gland epithelium does not result from hydrogen ion transport from one solution to the other, as is the case for the gastric mucosa with an equivalent alkalinization of the serosal solution during acidification of the lumenal solution[4]. While no attempt was made to identify the metabolic acid generated by the gas gland epithelium, the titration curves suggest that extrusion of hydrogen ions was associated with a weak electrolyte the pK of which was considerably higher than that of lactic acid. In all experiments there was no significant trans-epithelial potential difference. It was less than 1 mV. The d.c. conductance was 7·2 mmhos. cm.$^{-2}$.

The rate of secretion of hydrogen ions by two gastric mucosae of the pollack was also determined for comparison. When the serosal surface of these mucosae was bathed by a somewhat different solution containing sodium bicarbonate 30, sodium hydrogen phosplate 1 and histamine 0·1 mM/l., and both solutions gassed by 95 per cent oxygen and 5 per cent carbon dioxide, the mean rate of hydrogen ion secretion was 1·5 μequiv. cm.$^{-2}$ hr.$^{-1}$, the pH of the lumenal solution 4·2, wet weight 155 mgm. and conductance 7·8 mmhos. cm.$^{-2}$. As expected, there was a significant gastric trans-mucosal potential of 10–20 mV.

C. Adrian M. Hogben

Department of Physiology,
The George Washington University,
Washington, D.C., and
Mount Desert Island Biological Laboratory,
Salisbury Cove, Maine.
Sept. 29.

[1] Fange, R., *Acta Physiol. Scand.*, **30**, Suppl. 110 (1953).
[2] Ball, E. G., Strittmatter, C. F., and Strittmatter, C., *Biol. Bull.*, **108**, 1 (1955).
[3] Hogben, C. A. M., *Amer. J. Physiol.*, **180**, 641 (1955).
[4] Teorell, T., *J. Physiol.*, **114**, 267 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 8

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 6 p.m.—"Journey Into Spring" and "Between the Tides" (Colour Films).

Tuesday, December 9

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 9.30 a.m.—Discussion Symposium on "Low Temperature Heat Exchangers".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at 14 Belgrave Square, London, S.W.1), at 10.30 a.m.—Forestry Meeting.

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at 1 Birdcage Walk, Westminster, London, S.W.1), at 4 p.m.—Three papers on "The Dynamics of the Internal Combustion Engine".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

PARLIAMENTARY AND SCIENTIFIC COMMITTEE, GENERAL COMMITTEE (in Committee Room 12, House of Commons, London, S.W.1), at 5.15 p.m.—Dr. E. E. Pochin and Prof. B. W. Windeyer: "The Medical Problems of Living in the Nuclear Age".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. Ames: "Compounding and Vulcanisation of Silicone Rubber". 7 p.m.—Mr. C. G. Lynch: "Practical Safety in the Rubber Industry".

UNIVERSITY OF LONDON (at Imperial College of Science and Technology, London, S.W.7), at 5.30 p.m.—Prof. D. B. Spalding: "Heat Transfer in Rocket Motors".

IRON AND STEEL INSTITUTE (in the Weir Lecture Hall of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. N. P. Allen, F.R.S.: "The Mechanical Properties of the Ferrite Crystal" (Eleventh Hatfield Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Dr. R. Roberts: "Some Aspects of Radiation Induced Chemical Processes".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATE AND STUDENT SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Mr. H. E. Coles: "The Application of Electronics to Jet Engine Control".

SOCIETY FOR ANALYTICAL CHEMISTRY, BIOLOGICAL METHODS GROUP (at "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Fourteenth Annual General Meeting, followed by a Discussion Meeting on "Methodological Reminiscences" opened by Dr. S. K. Kon.

ROYAL AERONAUTICAL SOCIETY (in the Theatre, Park Lane House, 45 Park Lane, London, W.1), at 7 p.m.—Mr. S. S. Hall and Mr. A. Thomas: "Application of a Constant Frequency A.C. Electrical System to Aircraft and Missiles".

ROYAL AERONAUTICAL SOCIETY, GRADUATES' AND STUDENTS' SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. E. C. Bowyer: "The Future of the British Aircraft Industry".

Wednesday, December 10

IRON AND STEEL INSTITUTE (at Caxton Hall, Caxton Street, London, S.W.1), at 10 a.m.—Autumn General Meeting. Formal Business: Election of Members. Followed by technical sessions at Caxton Hall and also at the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

PHYSICAL SOCIETY, COLOUR GROUP (in Room 102, Northampton College of Advanced Technology, St. John Street, London, E.C.1) at 3.30 p.m.—Mr. F. H. Ludlam, Mr. P. Saunders and Dr. J. Hallett: "Some Colour Phenomena in Meteorology".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. C. B. Crampton: "Fabric Analysis of Moine and Cambrian Quartzites of the North-West Highlands of Scotland" (paper communicated by Dr. F. Coles Phillips).

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. A. Fraser: "Human Genetics at Two International Conferences".*

SOCIETY OF INSTRUMENT TECHNOLOGY, CONTROL SECTION (at Manson House, Portland Place, London, W.1). at 6 p.m.—Mr. H. Gill: "An Experimental Approach to some Control Problems of Multi-Stand Rolling Mills".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion Meeting on "The Use of the Microscope in Analysis" opened by Mr. R. L. Causer.

Wednesday, December 10—Friday, December 12

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS (at the Institution of Civil Engineers, Great George Street, London, S.W.1)—Winter Meeting, opened by Sir Vivian Fuchs.

Thursday, December 11

IRON AND STEEL INSTITUTE, IRON AND STEEL ENGINEERS GROUP (at Caxton Hall, Caxton Street, London, S.W.1), at 10 a.m.—Meeting on "Vacuum Processes in the Iron and Steel Industry".

SIR THOMAS MIDDLETON MEMORIAL TRUST (in the Auditorium, The Wellcome Building, 183 Euston Road, London, N.W.1), at 5.30 p.m.—Dr. John R. Raeburn: "Economic Aspects of Uncertainties in British Agriculture" (Sixth Middleton Memorial Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INSTITUTION OF ELECTRICAL ENGINEERS, at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. C. M. Cock: "The 'Deltic' Locomotive".

INSTITUTION OF MECHANICAL ENGINEERS, INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Discussion on "The Engineer in Production—His Training and Utilization".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. G. Porter: "The Triplet State in Chemistry" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. P. C. C. Garnham and Dr. D. J. Lewis: "Parasites of British Honduras with special reference to Leishmaniasis".

Friday, December 12

BIOCHEMICAL SOCIETY (in the Department of Biochemistry and Chemistry, The Medical College of St. Bartholomew's Hospital, Charterhouse Square, London, E.C.1), at 2 p.m.—378th Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Mathematics to Engineers" opened by Mr. M. Bridger.

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at Northampton College of Advanced Technology, St. John Street, London, E.C.1), at 7 p.m.—Dr. J. K. Aiken: "The Application of Sequestering Agents".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. T. E. Allibone, F.R.S.: "The Fusion of Heavy Hydrogen".

Saturday, December 13

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. J. C. Jewell: "Exploration of the Andes".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LABORATORY TECHNICIAN (with either experience in laboratory work, preferably in tissue culture, or the G.C.E. (Advanced) in two mathematical or scientific subjects) IN THE TISSUE CULTURE UNIT dealing with the production of kidney-cell cultures for growth of viruses—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey (December 10).

LECTURER IN ORGANIC CHEMISTRY at Birkenhead Technical College—The Director of Education, Birkenhead Education Committee, 63 Hamilton Square, Birkenhead (December 10).

DEMONSTRATOR OR TUTORIAL STUDENT IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs (December 13).

MATHEMATICIANS (with a first- or second-class honours degree or equivalent in mathematics or physics) IN THE HEALTH AND SAFETY BRANCH of the Atomic Energy Authority, to join a section concerned with assessment of safety from criticality hazards in the handling and processing of fissile materials and theoretical research into the factors governing criticality and the effects of super-criticality—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Warrington, Lancs, quoting Ref. 2768/T (December 15).

EXPERIMENTAL PSYCHOLOGIST TO JOIN THE BEHAVIOURAL RESEARCH UNIT—The Registrar, The University, Sheffield (December 16).

JOSEPH LUCAS RESEARCH STUDENT (with a good honours degree in mechanical or electrical engineering or physics, and preferably some research experience), for research into the initiation of explosions in gases, vapours and powder clouds; and a JOSEPH LUCAS RESEARCH STUDENT (with a good honours degree in some branch of engineering, physics or chemistry), for research into the mixing of powdered materials—The Registrar, King's College (University of London), Strand, London, W.C.2 (December 17).

USINES EMILE HENRICOT S.A. RESEARCH STUDENT (with a good honours degree in some branch of engineering), for research into various aspects of the mechanical behaviour of ball mills—The Registrar, King's College (University of London), Strand, London, W.C.2 (December 17).

ASSISTANT, Grade B (qualified to teach physics, and preferably the ability to teach applied physics), IN THE SCIENCE DEPARTMENT, Croydon Technical College, Fairfield, Croydon—The Chief Education Officer, County Borough of Croydon Education Committee, Education Office, Katharine Street, Croydon, Surrey (December 20).

POSTDOCTORAL FELLOW (with a Ph.D. or equivalent qualification) IN THE DEPARTMENT OF PHYSICAL AND INORGANIC CHEMISTRY, to carry out fundamental work on gas-phase chromatography—Prof. D. H. Everett, Department of Physical and Inorganic Chemistry, The University, Bristol 8 (December 20).

DEMONSTRATOR (ASSISTANT LECTURER) IN PHYSIOLOGY—The Registrar, The University, Leeds 2 (December 29).

LECTURER (with a knowledge of the meat industry or microbiological experience which can be applied to problems of food hygiene) IN APPLIED VETERINARY PATHOLOGY—The Registrar, The University, Liverpool (December 30).

ASSISTANT LECTURER (medically qualified) IN PHYSIOLOGY—The Registrar, The University, Sheffield (December 31).

SENIOR DEMONSTRATOR IN INORGANIC AND PHYSICAL CHEMISTRY; and a RESEARCH FELLOW IN CHEMISTRY—The Registrar, The University of Melbourne, Carlton, N.3, Victoria, Australia (December 31).

CHAIR OF NUCLEAR ENGINEERING—The Registrar, The University, Manchester (January 1).

SENIOR LECTURER IN EITHER INORGANIC AND PHYSICAL CHEMISTRY OR IN THEORETICAL CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (January 1).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a Ph.D. in astronomy or allied subject; or appropriate science degree (first- or second-class honours) with at least three years relevant (for example, postgraduate) experience, and preferably a knowledge of celestial mechanics) at the Royal Observatory, Cape Town—The Civil Service Commission, 30 Old Burlington Street, London, W.1, quoting Ref. S.4910/59 (January 8).

LECTURER (Grade II) IN INORGANIC CHEMISTRY—The Registrar, The University, Bristol (January 10).

CHAIR OF PSYCHOLOGY in the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 12).

CHAIR OF PHILOSOPHY in the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 30).

CHAIR OF GEOGRAPHY—The Registrar, The University, Sheffield (January 31).

LECTURER IN BOTANY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, January 31).

EXPERIMENTAL OFFICER (at least 26, with a general science degree with G.C.E. in mathematics at advanced level) in the Research Branch of Headquarters, Royal Air Force Bomber Command, for work in the computer section (mainly programming and operating electronic computers)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. A.427/8A.

LABORATORY TECHNICIAN (male or female, experienced in biology and interested in animals)—The Secretary, Furzedown College, Welham Road, London, S.W.17.

LECTURER, Grade IIa (with a first- or second-class honours degree) IN PHYSICS—The Principal, Paisley Technical College, 28–40 George Street, Paisley.

LECTURER (with good academic qualifications and industrial experience, preferably in the food industry) IN APPLIED MICROBIOLOGY—The Secretary-Treasurer, Royal College of Science and Technology, Glasgow, C.1.

PHYSICIST (with a first- or second-class honours degree in physics), to undertake original research in the field of mechanical properties of high polymers—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22, quoting Ref. P.5.

PROFESSOR OF COMMUNICATIONS ENGINEERING at the Indian Institute of Technology, Kharagpur, India—The Ministry of Labour and National Service (E.9), 26–28 King Street, London, S.W.1, quoting A.12/IND/244/TCS.

SENIOR PHYSICIST (with first-class professional qualifications, substantial experience of work with radioisotopes or ionizing radiations and the organizational ability to manage a department) AT THE RADIOCHEMICAL CENTRE, Amersham, to take charge of the Physics Department—The Group Recruitment Officer (1267/34), Atomic Energy Research Establishment, Harwell, Didcot, Berks.

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (mathematical statistician with a good academic record), to undertake research, to lecture and to teach statistics at undergraduate and postgraduate levels—The Secretary, Institute of Statistics, The University, St. Cross Road, Oxford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Home Defence and the Farmer. Pp. 32. (London: H.M. Stationery Office, 1958.) 1*s.* net. [710

Department of Scientific and Industrial Research. Problems of Progress in Industry No. 3: Management and Technology. By Joan Woodward. Pp. 40. (London: H.M. Stationery Office, 1958.) 2*s.* 6*d.* [710

University of London. University College Calendar, 1958–59. Pp. lxiv+502. (London: University College, 1958.) [710

A Story of Temperature Measurement. Pp. 20. (London: Negretti and Zambra, 1958.) [710

British Institution of Radio Engineers. Selected abstracts from *The Journal of the British Institution of Radio Engineers*, 1946 to 1958. Pp. 72. (London: British Institution of Radio Engineers, 1958.) 3*s.* 6*d.* [710

Figural After-Effects. By Peter McEwen. (*The British Journal of Psychology* Monograph Supplements, No. 31.) Pp. vi+103. (Cambridge: At the University Press, 1958.) 22*s.* 6*d.* net. [710

Flora of Tropical East Africa. Edited by C. E. Hubbard and E. Milne-Redhead. Cornaceae. By Dr. B. Verdcourt. Pp. 3. (London: Crown Agents for Oversea Governments and Administrations, 1958.) 1*s.* 6*d.* [710

Glossary of Atomic Terms. Pp. 1+58. (London: United Kingdom Atomic Energy Authority, 1958.) [710

Building Research Station Digest, No. 114 (September, 1958): Questions and Answers. Pp. 4. (London: H.M. Stationery Office, 1958.) 3*d.* [710

British Museum (Natural History). Economic Series No. 3A: Fleas: Their Medical and Veterinary Importance. Pp. 20. 2*s.* Bulletin of the British Museum (Natural History). Entomology. Vol. 6, No. 11: A Study of the Chironomidae (Diptera) of Africa South of the Sahara, Part 4. By Paul Freeman. Pp. 261–363+2 plates. 30*s.* Vol. 6, No. 12: New Species of Indo-Australian Geometridae. By L. B. Prout. Pp. 365–463. 28*s.* Vol. 7, No. 2: The African Species of *Stivalius*, a Genus of Siphonaptera. By F. G. A. M. Smit. Pp. 39–76. 10*s.* Vol. 7, No. 3: The Pseudococcidae (Hom.: Coccoidea) Described by C. K. Brain from South Africa. By G. de Lotto. Pp. 77–120. 12*s.* 6*d.* Vol. 7, No. 4: Revisions of Mallophaga Genera *Degeeriella* from the Falconiformes. By Theresa Clay. Pp. 121–207+9 plates. 30*s.* Geology. Vol. 3, No. 8: An Early Pleistocene Mammalian Fauna from Bethlehem. By D. A. Hooijer. Pp. 265–292+plates 32–35. 10*s.* Vol. 3, No. 9: The Upper Permian Flora of England. By H. M. M. Stoneley. Pp. 293–337+plates 36–40. 17*s.* 6*d.* Zoology. Vol. 5, No. 5: A Revision of the Genera *Nidalia* and *Bellonella*, with an Emendation of Nomenclature and Taxonomic Definitions for the Family Nidaliidae (Octocorallia, Alcyonacea). By Dr. Huzio Utinomi. Pp. 99–121. 7*s.* (London: British Museum (Natural History), 1958.) [710

Other Countries

Zoological Society of India, Calcutta. Indian Zoological Memoirs on Indian Animal Types. 6: Palaemon (The Indian River-Prawn). By Dr. S. S. Patwardhan. Second edition. Pp. xx+102. (Calcutta: Zoological Society of India, 1958.) Rs. 5. [299

Western Australia: Geological Survey. Report of the Geological Survey Branch for the year 1956. Pp. 7. Bulletin 110: The Geology of the Philips River Goldfield, W.A. By John Sofoulis. With Miscellaneous Reports by J. Sofoulis and A. J. Noldart. Pp. 240+1 plate+16 plates in separate Atlas. (Perth: Government Printer, 1958.) [299

Transactions of the American Philosophical Society. New Series, Vol. 48, Part 5: Surface Survey of the Northern Valley of Mexico—The Classic and Post-Classic Periods. By Paul Tolstoy. Pp. 101. (Philadelphia: American Philosophical Society, 1958.) 2 dollars. [299

The O.E.E.C. European Nuclear Energy Agency. Structure and Functions—First Joint Undertakings. Pp. 12. (Paris: Organization for European Economic Co-operation, 1958.) [110

Annual Report of the Calcutta School of Tropical Medicine and the Carmichael Hospital for Tropical Diseases, 1956–57. Pp. 157. (Calcutta: Calcutta School of Tropical Medicine and the Carmichael Hospital for Tropical Diseases, 1958.) [710

Institut Royal Météorologique de Belgique. Contributions. No. 41: High Atmosphere Densities. By Dr. Marcel Nicolet. Pp. 4. No. 42: Aspects Statistiques de Quelques Problèmes de Climatologie—Conférence donnée à la Société Belge de Statistique le 4 Décembre 1957. Par Dr. R. Sneyers. Pp. 9. No. 43: Distribution en Azimut des Parasites Atmosphériques Reçus à Dourbes sur ondes Kilometriques. Par A. Maenhout. Pp. 7. No. 44: Satellites Artificiels et Fusées. Par Alphonse Descamps. Pp. 21. (Bruxelles: Institut Royal Météorologique de Belgique, 1958.) [710

Talanta, Vol. 1, Numbers 1/2 (July, 1958.) (An International Journal of Analytical Chemistry.) Pp. 196. Published bi-monthly. Subscription (including postage): (a) per volume 17 dollars (Great Britain 120*s.*); (b) for subscribers certifying that the journal is for their own personal use—per annum 15 dollars (Great Britain 105*s.*). (New York and London: Pergamon Press, 1958.) [710

Estudos sôbre Mucorineas e sua Apliçãcao à Fermentação Alcoólica dos Amilacoes. Por D. de Giacomo. Pp. 101. (Rio de Janeiro: Ministério do Trabalho, Indústria e Comércio, Instituto Nacional de Tecnologia, 1956.) [710

Biologische Bundesanstalt für Land- und Fortwirtschaft in Berlin-Dahlem. Bibliographie der Pflanzenschutzliteratur, 1948–1949. Bearbeitet von Regierungsrat Dr. J. Bärner. Pp. xli+689. 65 D.M. Literaturquellen und ihre Kürzungen aus der Bibliographie der Pflanzenschutzliteratur. Bearbeitet von Regierungsrat Dr. J. Bärner. Pp. ii+167. (Berlin-Dahlem: Biologische Bundesanstalt für Land- und Forstwirtschaft, 1958.) [710

Sonderausschuss Radioaktivität, Bundesrepublik Deutschland—Erster Bericht (Januar 1958.) Pp. 68. (Stuttgart: Georg Thieme Verlag, 1958.) 4.50 D.M. [710

United States National Museum. Bulletin 214: Review of the Parrotfishes, Family Scaridae. By Leonard P. Schultz. Pp. v+143+27 plates. (Washington, D.C.: Government Printing Office, 1958.) 75 cents. [710

Bulletin of the Astronomical Institute of the Netherlands. Vol. 14, No. 487 (1958 August 6): Photographic Observations of Minor Planets and of Comets made in 1954–1957. By G. Pels. Miscellaneous Observations of Some New Minor Planets. By G. Pels. Pp. 161–214. (Leiden: Astronomical Institute of the Netherlands, 1958.) [710

Annalen van de Sterrewacht te Leiden. Deel 21, Derde Stuk: Estimates of 140 Variable Stars on Franklin-Adams Plates Centered at $l = 325°$, $b = 2°$, taken by the Late Dr. H. Van Gent, discussed by L. Plaut. Pp. 217–250. (Leiden: Astronomical Institute of the Netherlands, 1958.) [710

The Rise of Science Understanding. (Based on an article in *Science*, September 3, 1958. Revised to September, 1958.) Pp. 15. (Washington, D.C.: Science Service, 1958.) [710

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £7/15/–, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2
Telephone Number: Holborn 4743

All rights reserved. Registered as a newspaper at the General Post Office